MODERN PLASTICS

DESIGNED AND PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER

ACRYLIC—GLAMOUR PLASTIC WITH MUSCLE *p. 78*

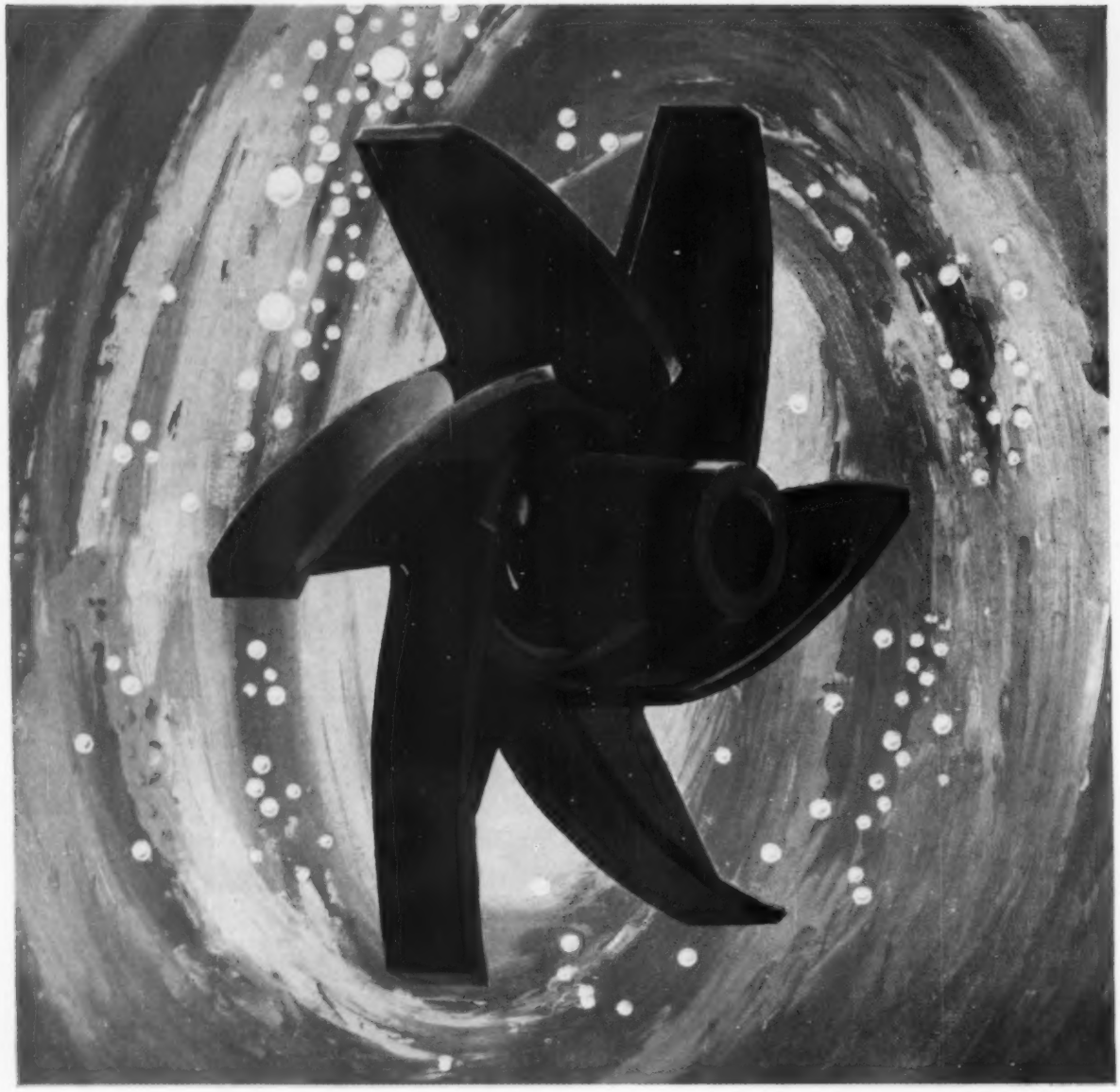
Potentials for polypropylene film *p. 87*

Upgrading with special decorative effects *p. 94*

How to coat acetal moldings *p. 97*

DECEMBER 1961

One of a series directed to IDEA-MEN



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MODERN PLASTICS*

Volume 39, Number 4 December 1961

• THE PLASTISCOPE

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Section 2 208

Price battle shaping up . . . Price reduction for ABS (p. 39); New variations in polyester film . . . A wrapper for lettuce (p. 41); New markets for PVC . . . Vinyl for shoes (p. 43); Will plastics hold up in a building? (p. 45); Photopolymer plate costs reduced (p 208); Expansion (p. 215).

• EDITORIAL

New elements in plastics distribution 77

Don't overlook the growing importance of the distributors, jobbers, or wholesalers who handle specialty plastics items and small-quantity orders. They are close to the consuming public and can be important to the future of plastics.

• GENERAL

Glamour plastic gets muscles 78

Cover story: New companies are going into the business of making acrylic, special formulations are being developed, and new applications are opening up at a rate fast enough to focus a good deal of attention on what has been happening in the field. Copolymers and alloys represent one of the new directions, acrylic sirups for glass-reinforced products another, and tough oriented sheeting for signs, windshields, and building applications a third. Here are the ways in which these developments may affect tomorrow's markets.

Simplified wiring for '62 cars 83

The compact design, lower costs, and ease in servicing which plastics have brought to household and appliance electrical wiring systems is now spreading to other fields. The automotive market is one such user, with polypropylene and printed circuitry spearheading the newer developments.

Polycarbonate for throw-away parts 84

Despite its label as a premium-priced material, when polycarbonate competes against some of the metals and metal-glass combinations the cost savings possible are little short of phenomenal. In the heart-lung machine described here, savings were so impressive that the polycarbonate parts are actually looked on as "low-cost disposables."

PS foam with PE skin—from one mold 86

Molded expandable polystyrene products can be given a high-quality, tough, glossy surface thanks to a new technique involving the use of powdered polyethylene as part of the foam-molding cycle. Through fusion, the polyethylene becomes a continuous, one-piece skin for the foamed core.

Polypropylene: what should film users look for? Part III 87

Processors and end-users interested in the exciting potential for polypropylene film will find here a detailed study of advantages and limitations. Price, properties, methods of decorating PP film, new machines for handling the film, and current applications are all covered. By 1965 markets can run anywhere from 50 to 150 million pounds.

Nylon parts—large and low-cost . . 92

Production of massive caprolactam nylon parts at cost similar to, if not less than, those of metal castings is opening new markets in heavy industry. Applications, including bushings and bearings, huge gears, roll covers, and slipper blocks, are described.

Special decorative effects 94

New coloring materials, including metallics, pearlescents, and glitter, that can be uniquely combined with plastics are becoming more and more important. Here is how end-users can utilize them to advantage to create a wide variety of unusual three-dimensional effects.

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18th SPE Antec

17th SPI RP Conference

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posable bulk milk containers . . . Vinyl mats at half the cost of rubber . . . Decorative wine rack of molded polystyrene (p. 153); Automatic molding brings 36% cost saving . . . RP is wed to wood and aluminum in new ladder . . . Fluorocarbon glider for easier ironing . . . New approach to one-can epoxies (p. 154).

• ENGINEERING SECTION

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An economical new surface treatment makes it possible to achieve superior adhesive bonding and excellent paint and coating adhesions on parts made of acetal resin.

By Walter M. Bruner and Carlos M. Baranano

Hi-Fi textures for plastics **109**

A method of mass reproduction of such natural surfaces as wood, marble, or stone, for use in molding, embossing, or formulating textured plastics parts is here described. Cold-setting polysulfide rubber is the key to the operation.

By J. H. Tompkins and K. R. Smith

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• TECHNICAL SECTION

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Furfuryl alcohol as a resin modifier . . **135**

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By Lloyd H. Brown and E. K. Stigger

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• Coming Up . . .

The theme for our January review issue is "A penetrating look at plastics," and it will provide an analysis in depth of all the major plastics materials, both in terms of 1961 performance and prospects for the years ahead. Our annual literature review and machinery statistics, traditionally published in January, will appear in our February and March issues, respectively. (The switch was made to provide a more reliable set of figures, rather than estimates subject to last-minute changes) . . . January Engineering lead will tell how to set up production systems for fluidized bed coating . . . Technical lead will cover polyester polymerization with mixed catalyst systems . . . Also in the works: New markets for plastics in the vending field.

Modern Plastics Executive and Editorial Offices: 770 Lexington Ave., New York 21, N.Y. Please mail all correspondence, change of address notices, subscriptions orders, etc., to above address. Quotations on bulk reprints of articles appearing in this issue are available on request.

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Member Audit Bureau of Circulations, Associated Business Publications, The Society of the Plastics Industry, Inc., and other plastics associations throughout the world. Modern Plastics is regularly indexed in the Applied Science & Technology Index and Industex. Printed in U.S.A. by Hildreth Press, Inc., Bristol, Conn.

Modern Plastics issued monthly by Breskin Publications Inc. at Emmett St., Bristol, Conn. Modern Plastics Encyclopedia Issue published as the second issue in September by Plastics Catalogue Corp. at Emmett St., Bristol, Conn. Second class postage paid at Bristol, Conn. Subscription rates (including Modern Plastics Encyclopedia Issue): in U.S., its possessions, and Canada, 1 year $8, 2 years $14, 3 years $18; all other countries (payable in U.S. currency), 1 year $25, 2 years $45, 3 years $60. Single copies in the U.S., its possessions and Canada, $1 each (Encyclopedia Issue, $4); all other countries, $2.50 (Encyclopedia Issue $8).

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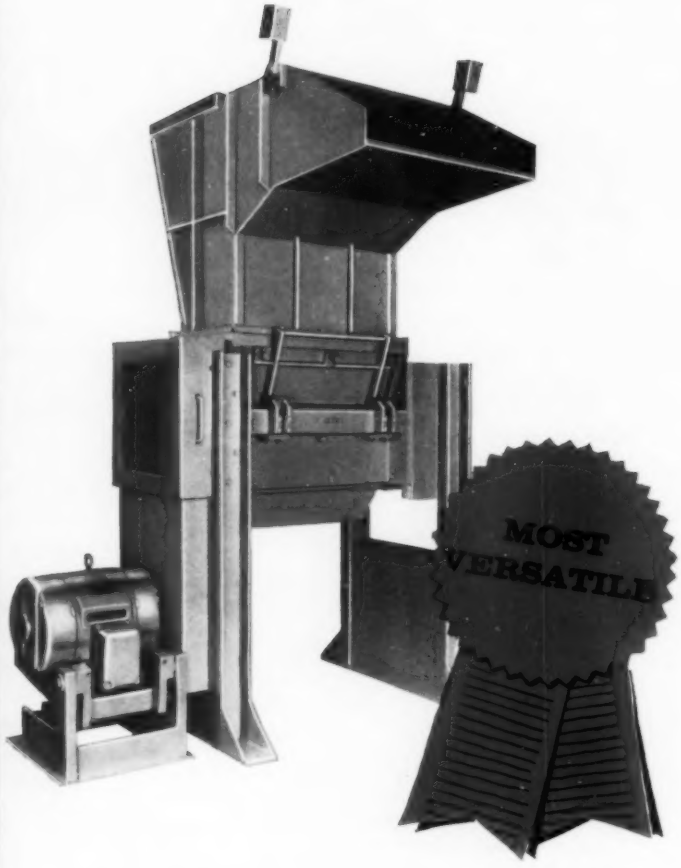

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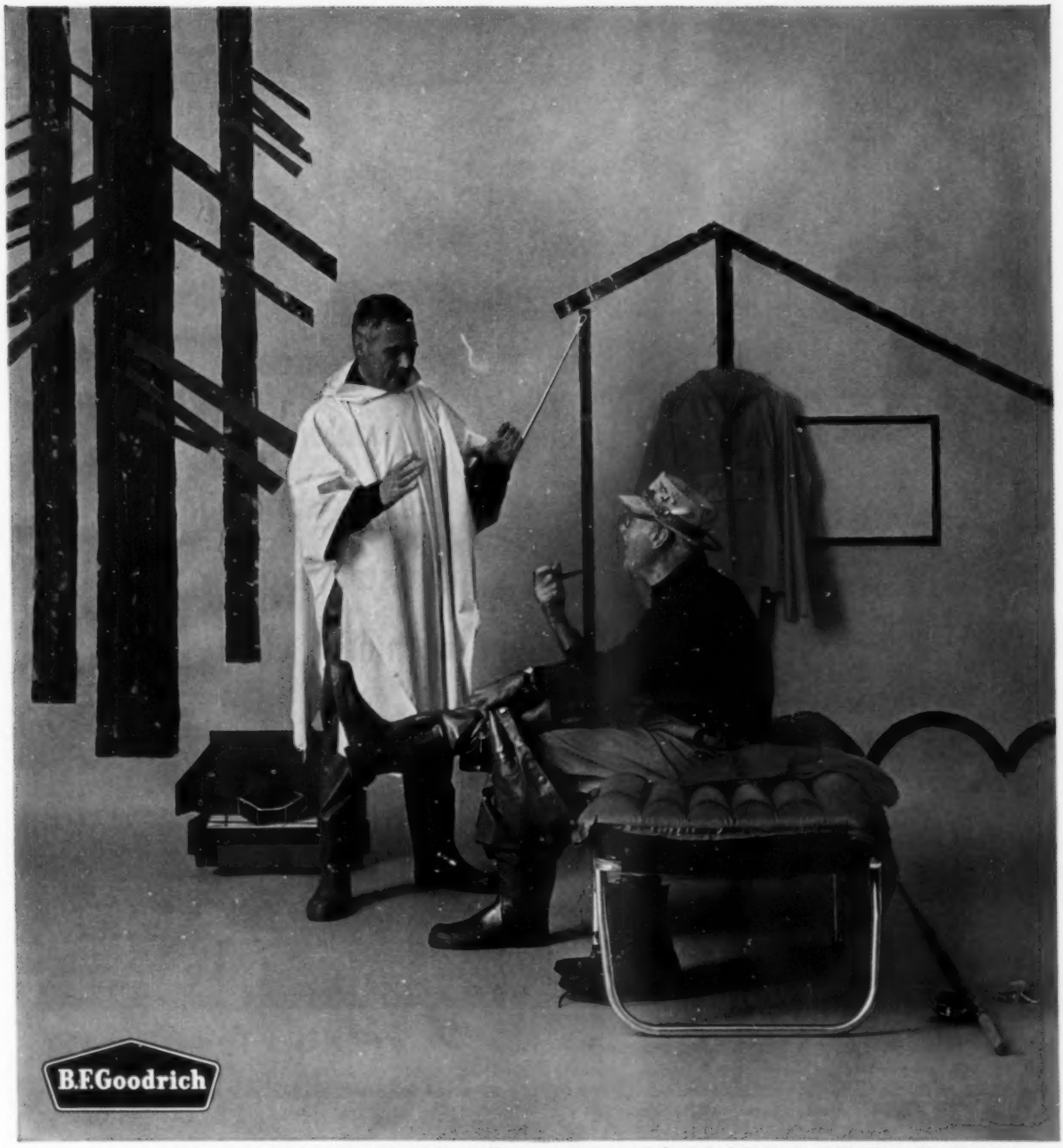

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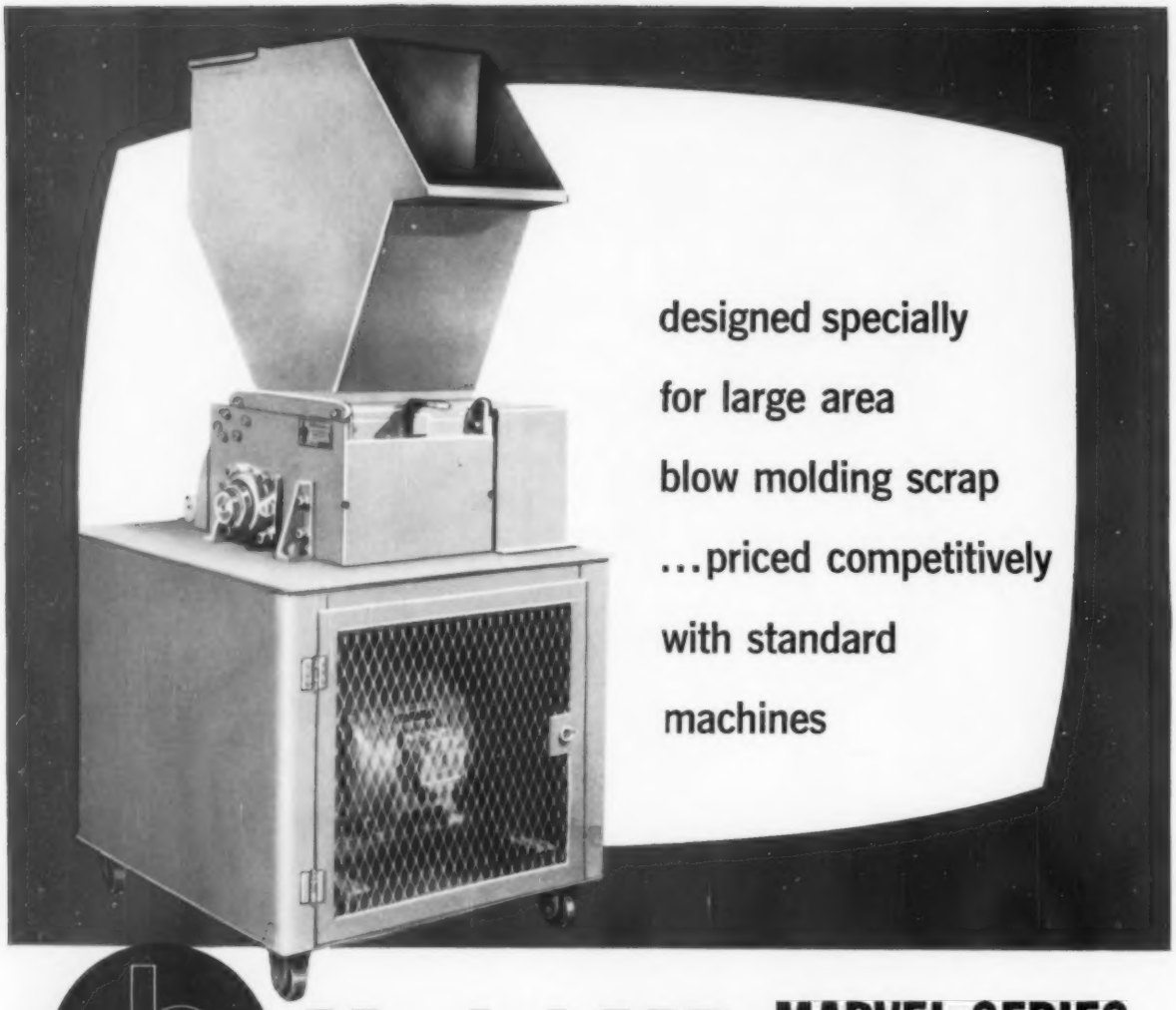

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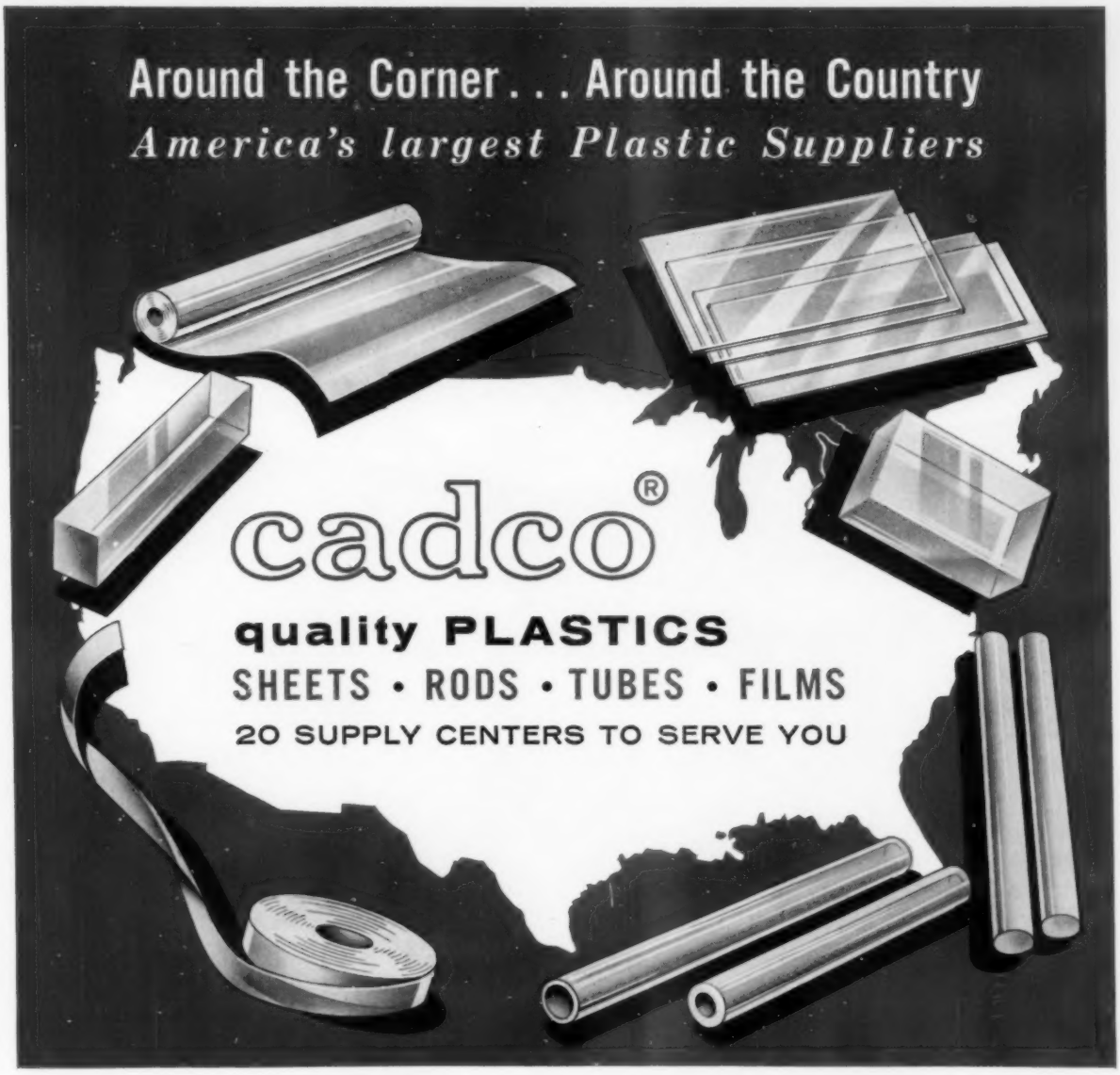

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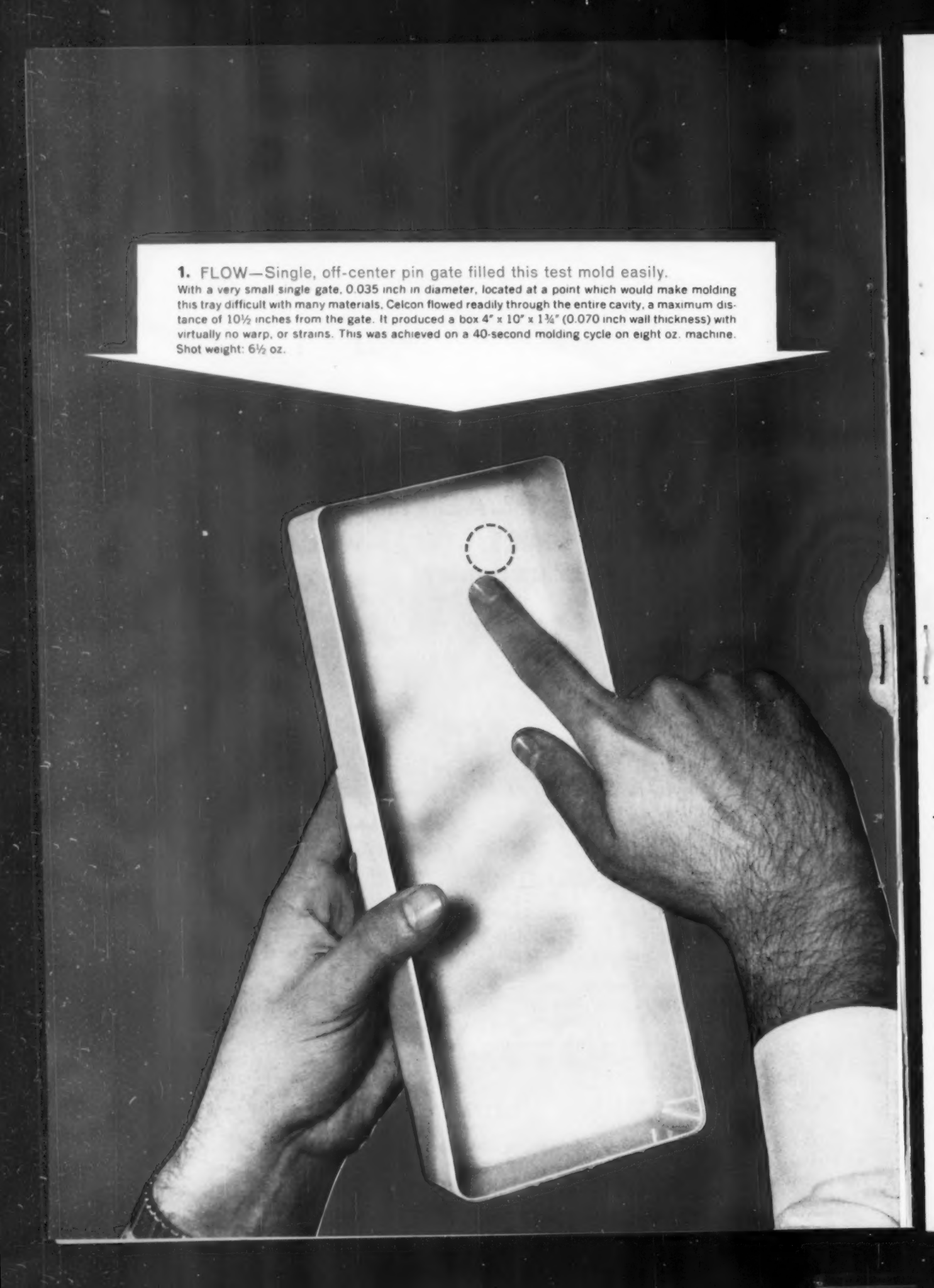
1. FLOW—Single, off-center pin gate filled this test mold easily.

With a very small single gate, 0.035 inch in diameter, located at a point which would make molding this tray difficult with many materials, Celcon flowed readily through the entire cavity, a maximum distance of 10½ inches from the gate. It produced a box 4" x 10" x 1¾" (0.070 inch wall thickness) with virtually no warp, or strains. This was achieved on a 40-second molding cycle on eight oz. machine. Shot weight: 6½ oz.



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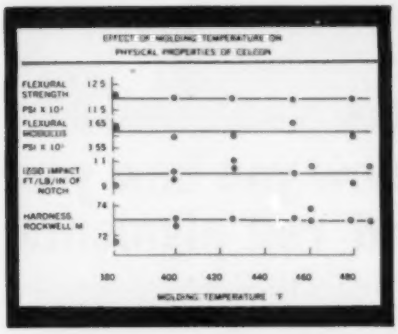
It has over 100°F. molding temperature range, during which essentially no polymer degradation occurs. Celcon flows easily and evenly; lends itself to fast cycle molding.

Moldability is only part of the good news about Celcon. There's more, including high-strength, resistance to chemical attack, unusual durability over long periods of time and conditions of use. The coupon will bring you complete details promptly.

2. BROAD MOLDING RANGE—Over 100°F.



Celcon has a broad molding range—over 100°F., during which the stability of the polymer is essentially unaffected. It molds well from 360° to 480°F., although material temperatures of 380° to 420°F. are suggested as usually best from the standpoints of cycling and optimum part properties and appearance.

3. REMOLDING—Celcon regrounds show little change from virgin material.

Comparison of ASTM properties of virgin Celcon with regrounds put through the molding operation five times indicates no significant change in properties. Celcon can be molded and remolded a number of times—thus allowing reuse of scrap on a normal basis.

EFFECT OF REMOLDING ON PROPERTIES CELCON COPOLYMER

		1st MOLDING	5th MOLDING
TENSILE PROPERTIES			
YIELD STRENGTH	PSI	8800	8400
ELONGATION AT YIELD	%	12	12
TENSILE MODULUS	PSI X 10⁵	3.75	3.70
BREAK STRENGTH	PSI	8000	7800
ELONGATION AT BREAK	%	60	60
FLEXURAL STRENGTH, 5%	PSI	13000	12000
FLEXURAL MODULUS	PSI X 10⁵	3.65	3.65
IZOD IMPACT STRENGTH NOTCHED 73°F. 50% RH	FT LB/IN	1.1	1.1
-40°F		1.0	1.0
UNNOTCHED— 73°F. 50% RH	FT LB/IN	20	20
HEAT SOFTENING POINT	C	160	160

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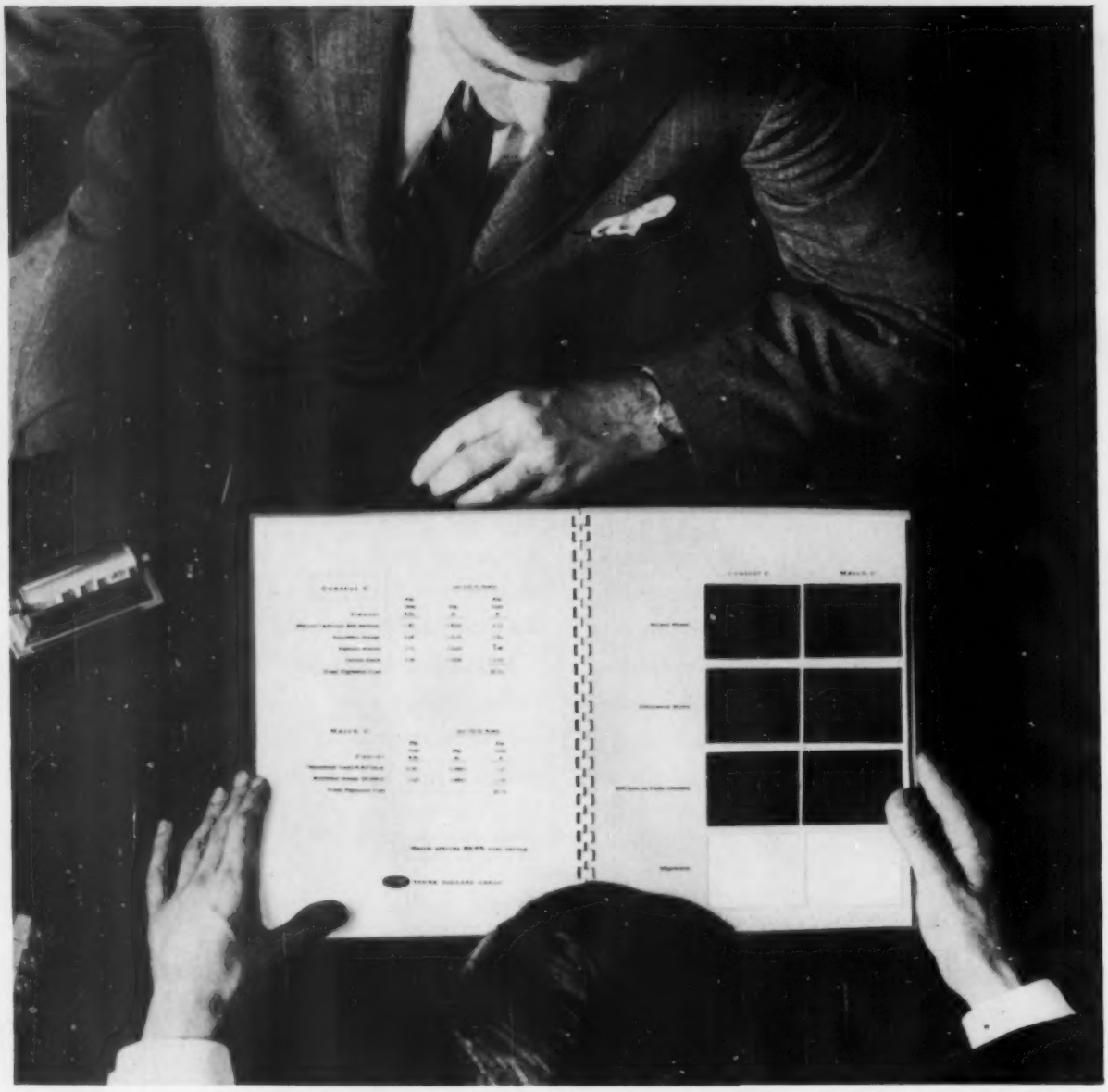

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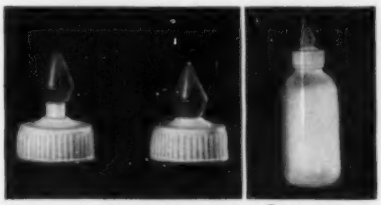
Packaging Notes

Beer in 16-oz. bottles is moving "at a fantastic rate" packaged five to a polyethylene bag, according to a leading New York brewer. The multi-packs are being promoted by suggesting that ice cubes be put into the 2½ mil, re-usable bags to keep beer cold for picnics, outings, etc.

CIRCLE ③ ON COUPON

Non-clogging closure for squeeze bottles is ideal for use with such viscous liquids as glues, detergents and hand creams. Injection molded of U.S.I.'s PETROTHENE polyethylene resin, it features a sliding overcap which seals off orifices when product is not being dispensed. Available in standard diameters of 18, 20, 22, and 24 mm, and in an assortment of colors.

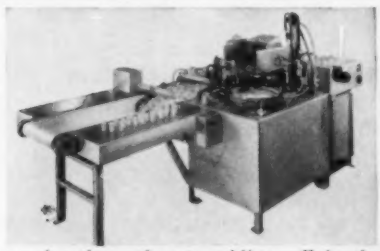


CIRCLE ④ ON COUPON

Bottle finisher, newly available from a Connecticut company, is said to provide clean, continuous cut-off, reaming or chamfering. It handles blow-molded polyethylene containers having neck sizes up to 2″ in diameter. Takes only 36″ x 30″ of floor space. Operation is cycled automatically by foot switch. Loading is manual.

CIRCLE ⑤ ON COUPON

Polyethylene surface treater prepares bottles, vials, novelties for printing, silk screening or labeling. The machine bombards the object with electrical energy,



causing the surface to oxidize sufficiently to permit adhesion of inks and glues. This unit can be incorporated into a conveyor line and adjusted to the production rate. Oxidizing unit requires less power than an ordinary household iron.

CIRCLE ⑥ ON COUPON

Rotational Molders Turning to MICROTHENE® Powdered Polyethylene

U.S.I.'s Finely Divided Resin Offers Significant Economies Over Vinyl Plastisols Commonly Used

MICROTHENE powdered polyethylene, introduced by U.S.I. only about two years ago, has already achieved recognition in the production of large items by powder molding. It is now promising to open new markets for polyethylene in another area: rotational molding of regular and irregular hollow objects. Volleyballs, footballs, baseballs, artificial fruit, pipe fittings, toy horses and bottles are typical.

Rotational molding has been extensively used with vinyl plastisols. In this technique, hollow articles are formed in heated, rotating molds — usually of the multiple cavity type. Existing equipment and operating conditions can be readily adapted for use with MICROTHENE.

Costs No More, Less Needed

While offering a number of advantages over the vinyl plastisols, powdered polyethylene is making more and more converts among rotational molders on the basis of potential savings alone. A large toy manufacturer, for example, switched from a hard vinyl plastisol to MICROTHENE when he discovered he could produce each item for 40¢ less. And another, a maker of toy balls, found that polyethylene offered equivalent performance at a 66% dollar savings.

MICROTHENE sells for 35¢ per pound in truck load quantities in the U.S. — a price comparable to that of the plastisols. But, MICROTHENE has a lower specific gravity (0.92 compared to vinyl plastisol's 1.4), so less is needed to obtain a desired wall thickness. Moreover, polyethylene offers superior stiffness and hardness—making possible even greater weight savings.

Other Advantages

Since no plasticizer is used with polyethylene powder, plasticizer migration is eliminated. MICROTHENE arrives ready for use . . . can be dry blended with pigments to produce colored parts. Also to be considered: *The use of powdered polyethylene in rotational molding applications does not infringe on any patent covering the use of liquid plastisols.*

Samples of MICROTHENE are available from U.S.I. for evaluation; also, technical assistance on its use in either rotational or powder molding.

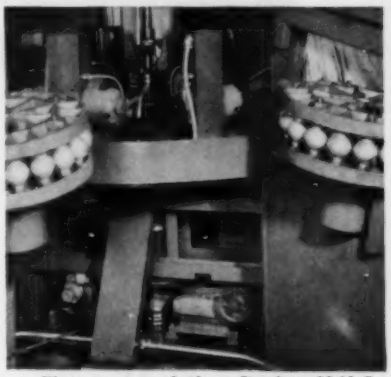


Photo courtesy of Akron Presform Mold Co.

MICROTHENE can be molded in standard rotational molding equipment currently using vinyl plastisols with virtually no modification. An Ohio firm makes this 6-spindle machine capable of producing up to 1620 items per hour.

CIRCLE ① ON COUPON

Polyethylene Paneling Shelters Construction Sites

Bad weather doesn't have to interrupt building operations. The protective polyethylene panels, available from an English firm, are designed for use with all types of scaffolding. They can be set up as a complete shelter, as a roof, or simply to screen the windward side of a site as above.

CIRCLE ② ON COUPON

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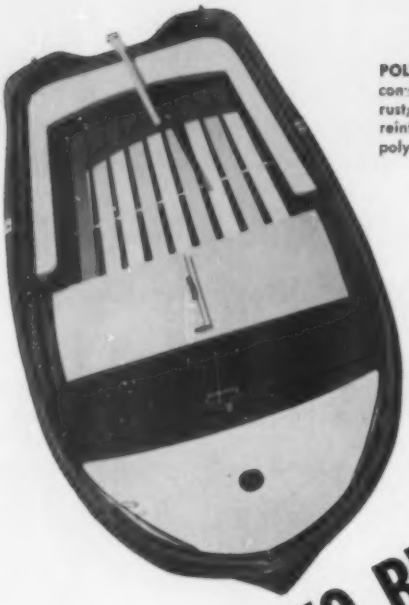

POLYETHYLENE HULL. First full-sized (9 ft. long, 4 ft. beam) hull of conventional polyethylene. One piece. Light (60-lb.). Tough (won't dent or rust; takes 5 hp outboard). Economical (retails lower than comparable reinforced plastic boats). Powder molded from U.S.I.'s MICROTHENE® polyethylene by Sintrex Division of Amos-Thompson Corp., Edinburg, Ind.

TWO BIG FIRSTS FOR MICROTHENE® POWDER MOLDING

POLYETHYLENE MEAT TANK. One-ton capacity. For transporting, storing, processing meats. Thick walled. Light. Easily cleaned. Resists juices and chemicals. Powder molded from U.S.I.'s MICROTHENE® polyethylene by Sintrex Division of Amos-Thompson Corp., Edinburg, Ind.

Sintrex Division's plastic boat and one-ton meat tank are two new large-size commercial products made from powdered polyethylene to be marketed in this country.

They're both produced by powder molding technology from MICROTHENE powdered polyethylene supplied by U.S.I. This new polyethylene molding technique has been used in Europe, but was little used in America until U.S.I.'s MICROTHENE was introduced two years ago.

Advantages of powder molding with MICROTHENE:

- **Large polyethylene parts are easy to produce.** Moldings made by Sintrex would be difficult or impossible to produce by conventional plastics fabrication methods such as injection molding or blow molding. Moldings are smooth, seam-free, strong.
- **Speed of production.** Sintrex produces plastic boat hulls many times faster than is generally possible by manufacturing methods for reinforced plastics.
- **Economy.** Process requires only simple, relatively inexpensive molds. Many products made by this method have a price advantage over those molded by other procedures.

Powdered Polyethylene for a Variety of Applications

Besides powder molding, versatile MICROTHENE powdered polyethylene may be used as protective or decorative coating on rigid substrates such as metal and glass. Other applications include rotational molding of hollow shapes and heat seal coatings for both woven and nonwoven fabrics. Write U.S.I. today for samples of MICROTHENE and for complete technical data.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
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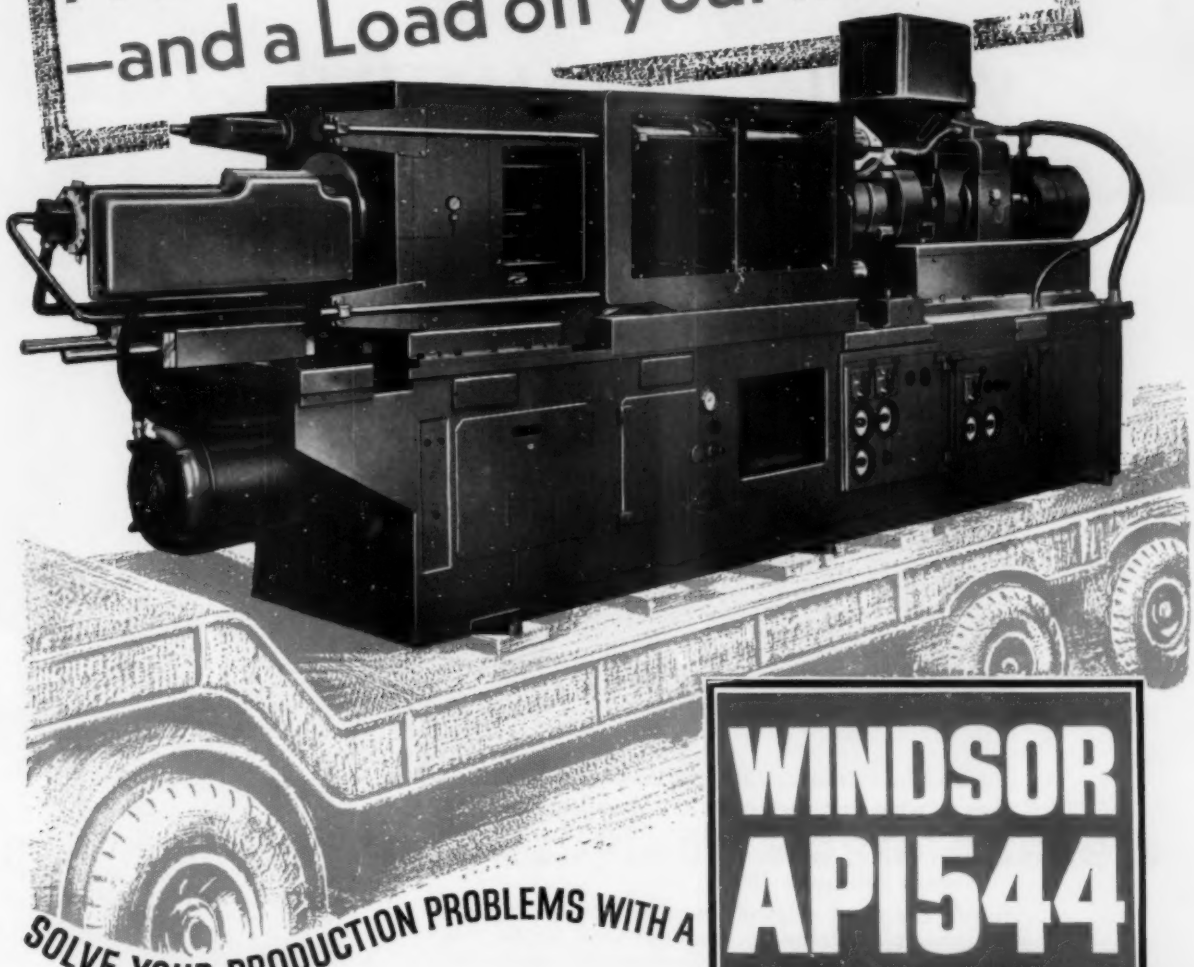
A Load for your works —and a Load off your mind...



SOLVE YOUR PRODUCTION PROBLEMS WITH A

WINDSOR AP1544

INJECTION MOLDING MACHINE

When plastic's production demands are bigger than existing production facilities, injection moulding machines like the AP1544 are the obvious answer. Incorporating the most advanced developments in machine design it makes the most profitable production possible under the most competitive conditions. Higher output—greater flexibility—better quality control and less maintenance requirements are features that put the AP1544 in a class of its own.

- ***Automatic sprue breaking***
- ***Proportional pyrometric temperature controllers***
- ***Controlled cycle delay equipment***
- ***Variable screw speed***

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The Windsor range includes INJECTION MOULDING MACHINES in capacities from 1 to 210 ozs. and EXTRUSION MACHINES with outputs up to 450 lbs. per hour.

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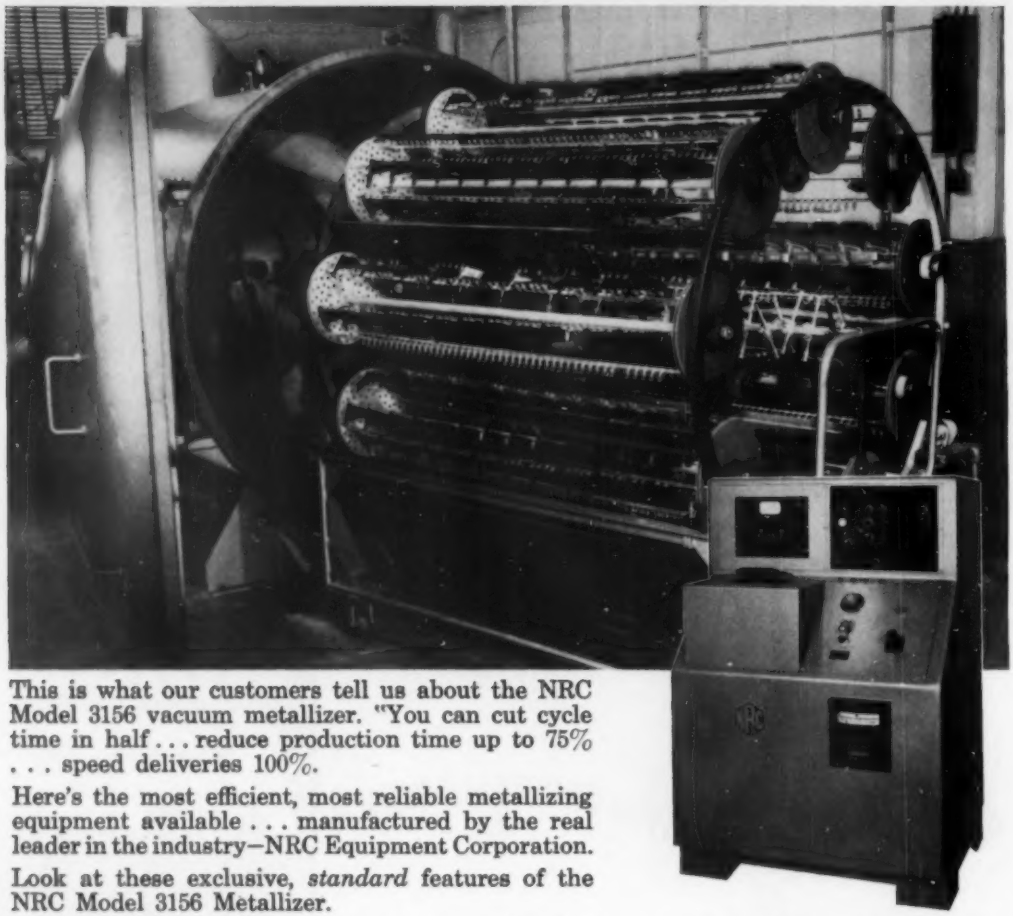

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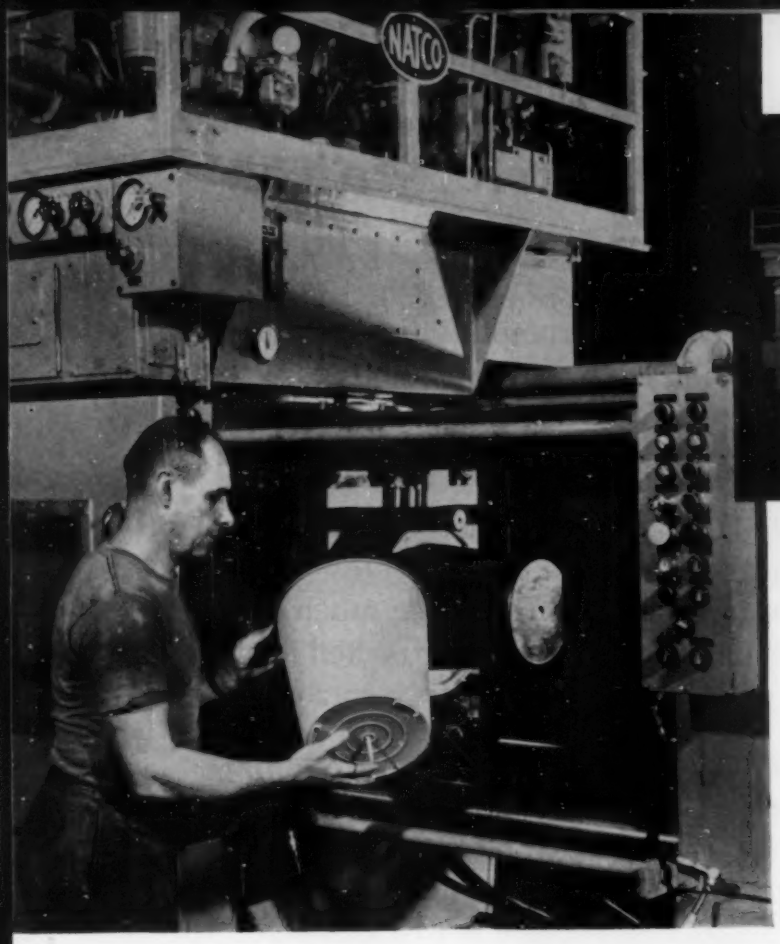

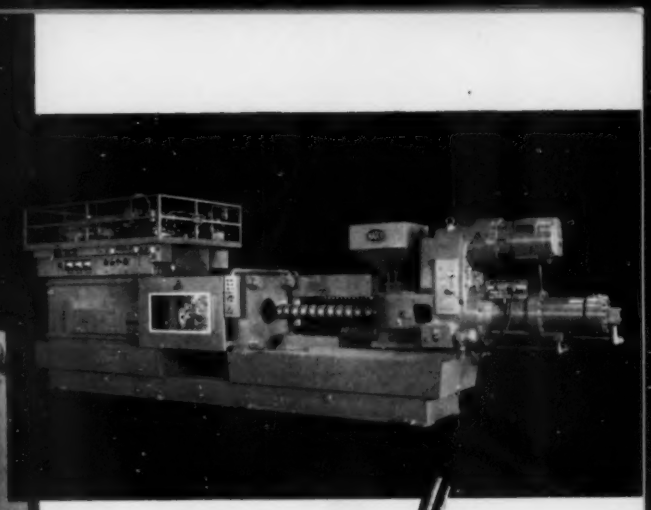

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NATCO SCREW-RAM

molds 18 oz. polyethylene waste baskets

FAST!

Anyway you add it, Natco's new reciprocating screw injection molding machines will make your present production schedules obsolete! Imagine molding this 18 oz. waste basket at a rate of four per minute! Natco's new screw-ram machines will increase your production from 20 to 100 percent! You'll get better parts both in appearance and physicals. Dry coloring is excellent without the use of dispersion discs. Scrap loss is so low you won't believe the figures. Color changes can be made quickly without wasting valuable material and time.

With a Natco Screw-Ram, the only limiting condition is the time required to cool the part in the mold. Melt capacity and machine operating time are no longer limiting factors. Parts can be removed and the mold closed while the extruder melts material for the next shot! Natco's precision volumetric shot control guarantees consistent accuracy.

Regardless of the type of thermo-plastic you mold, investigate what the Natco Screw-Ram will do for you. Stock sizes from 325 to 1200 tons (35 to 140 ozs.). Write today for specifications.

THE MOLDER'S MOLDING MACHINE

NATCO
SCREW RAM

NATIONAL AUTOMATIC TOOL COMPANY, INC.
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RICHMOND, INDIANA, U. S. A.

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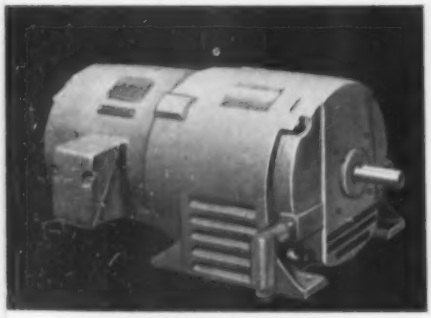
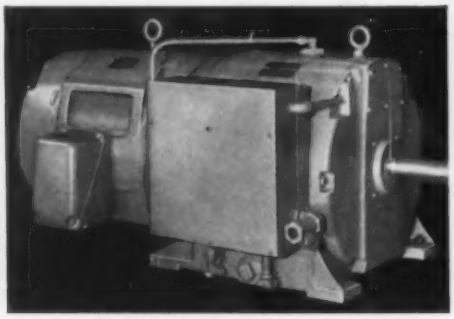
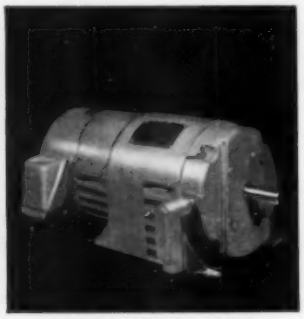


AIR COOLED, 7-1/2 to 100 HP



WATER COOLED, 25 to 150 HP



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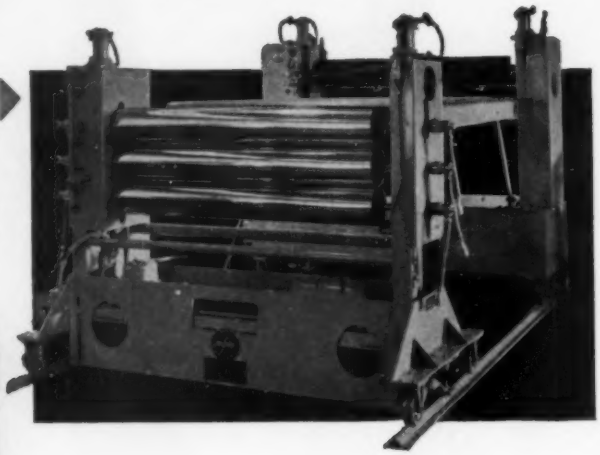

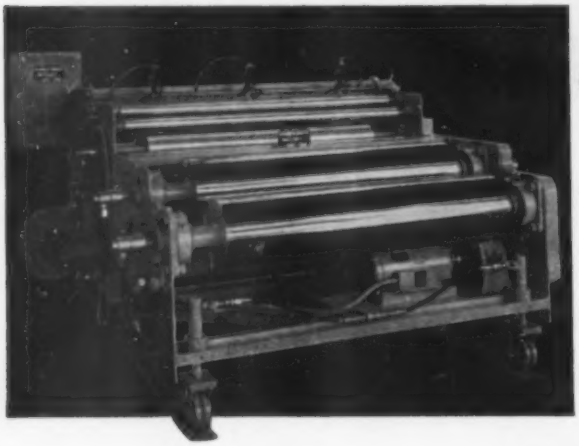

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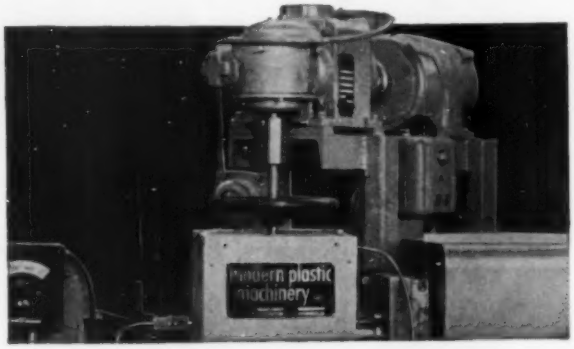

For more information on these and other MPM machinery, write for our new 16-page illustrated catalog and specifications sheets.

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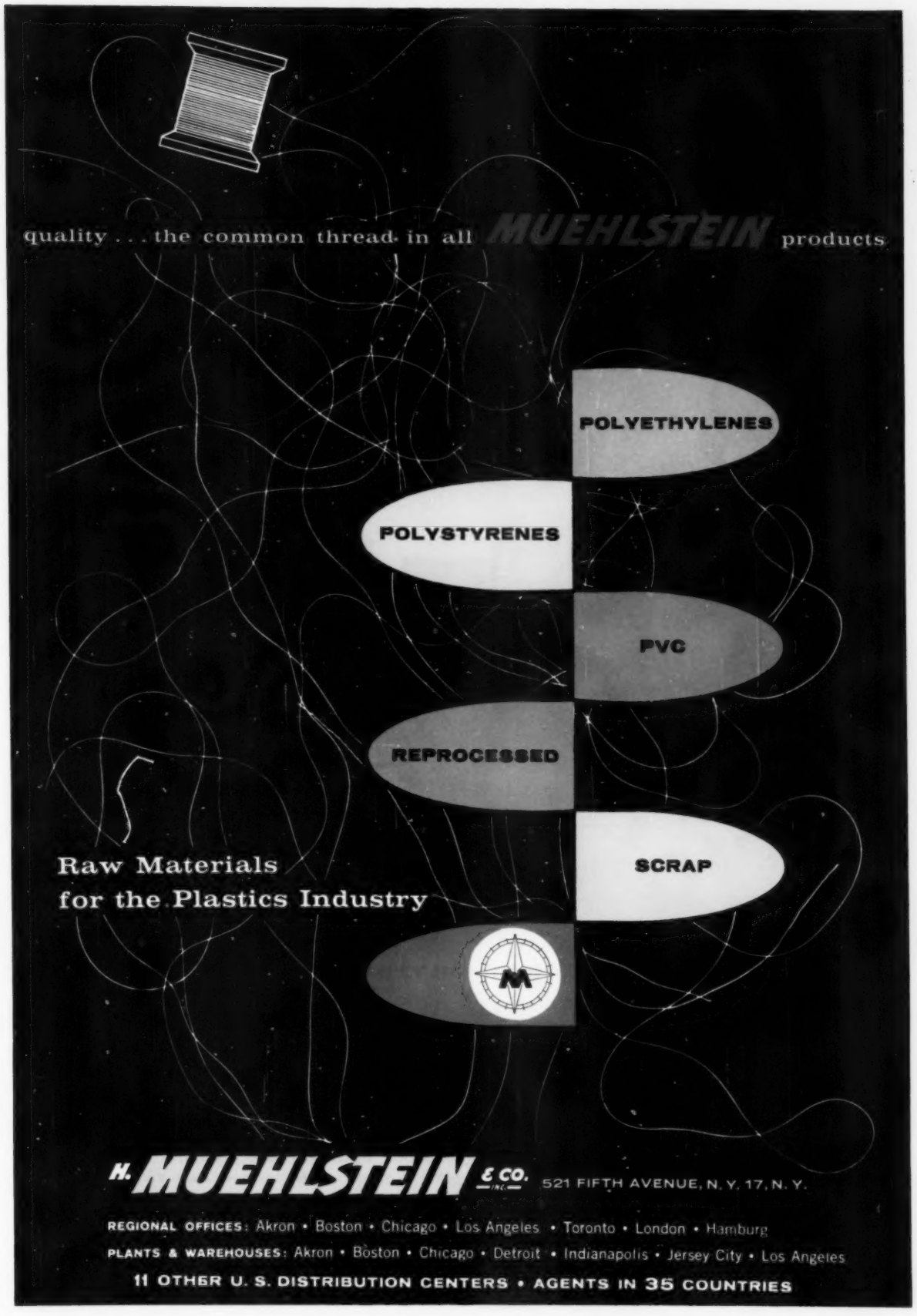
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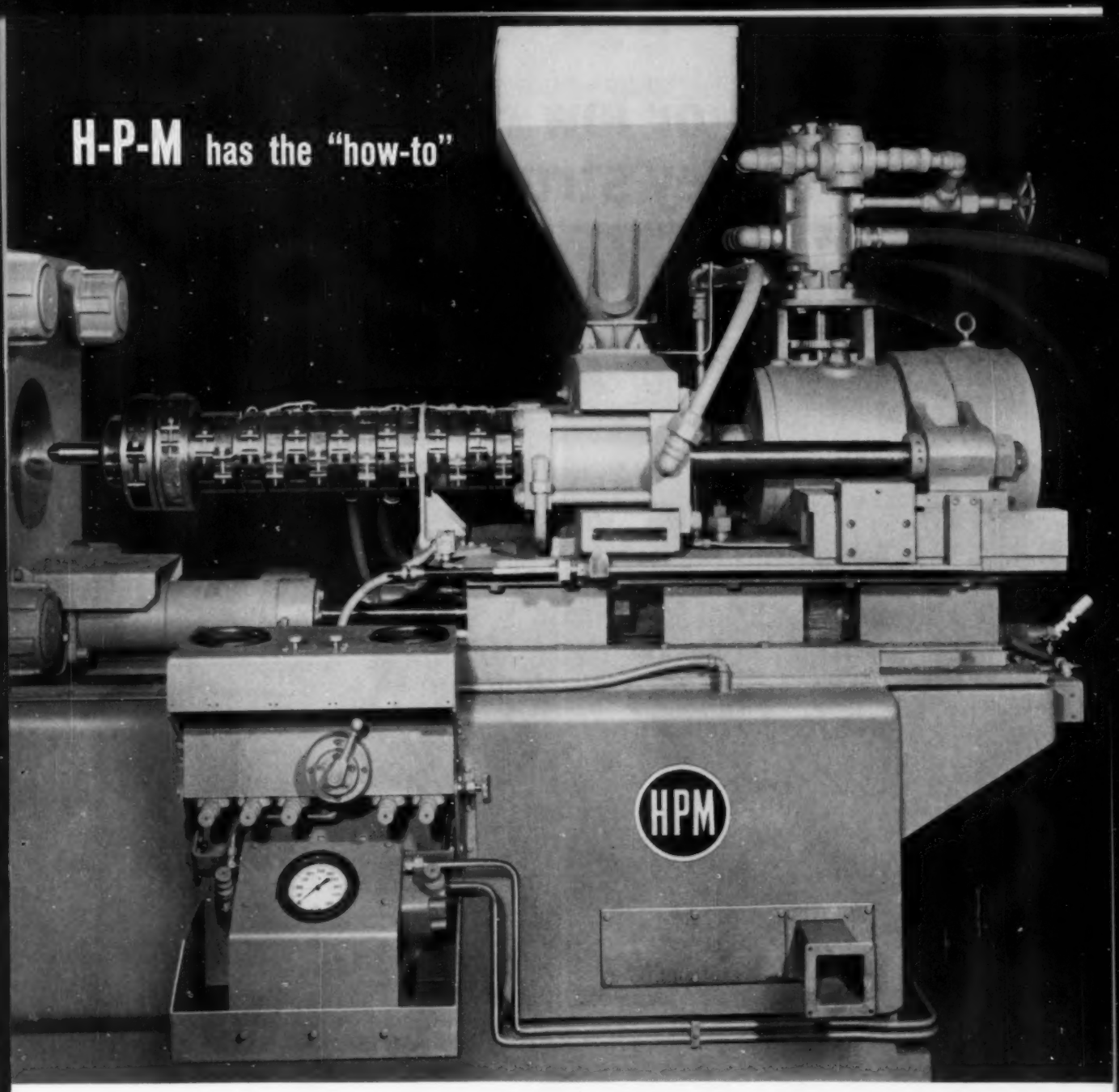


All-Hydraulic Extruder Type Injection Machine Makes Hit with Molders

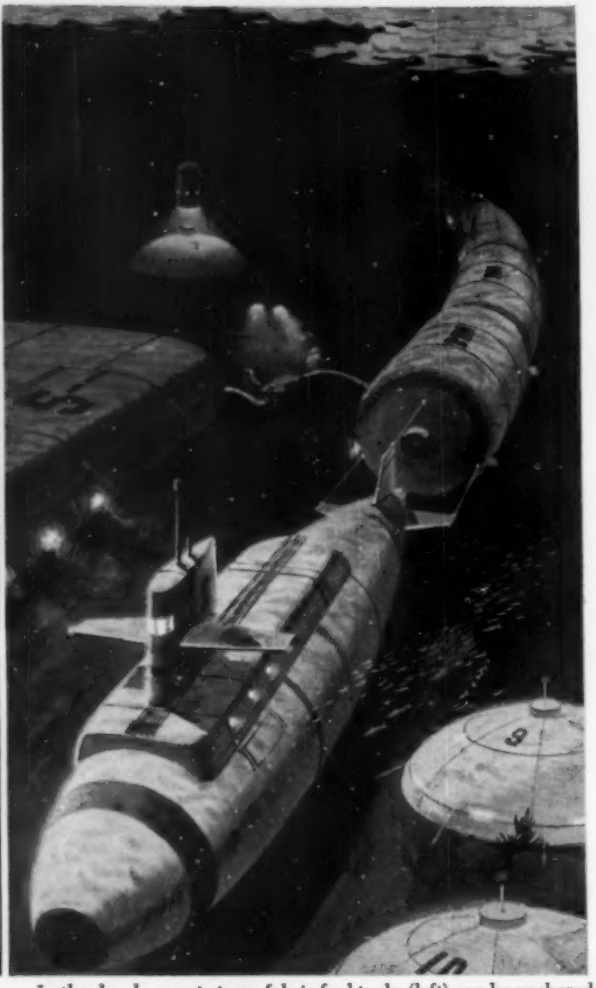
Pictured here is the business end of H-P-M's new in-line reciprocating screw injection machine (IX Model) which has been a complete success in molding the recently developed heat-sensitive and more viscous types of plastic materials. Following are a few of its features that molders are buying: **Hydraulic motor drive provides positive protection against screw overload. ■ Two speed-torque ranges are available by simple valve selection. No change gears are used and no clutches or shear devices are needed to limit torque. Within the selected speed-torque range, the speed of rotation is infinitely variable. ■ Easily adjustable back pressure control for proper melting and blending of materials. ■ Exclusive mechanism permits almost effortless pivoting of extruder barrel for easy screw removal. ■ Fast material and color change. ■ Interchangeable screws and screw tips for molding different types of material.** Before you buy extruder type injection, see H-P-M's new machines. Send for the IX Model bulletin, today.

H-P-M DIVISION KOEHRING COMPANY, MT. GILEAD, OHIO, U.S.A. HPM

H-200

High road or low road . . . fabrics figure as key structural material

On the drawing board: orbiting space stations (top) fold to fit in rocket nose cone, inflate with gas. Astronauts are protected by space suits of special coated fabrics.



In the development stage: fabric fuel tanks (left) can be anchored or towed by submarine for underseas storage. Right: fabric pressurized hemispheres for on-the-bottom mining.

Problem: build orbiting space stations—durable, yet light and compact for stowing aboard rockets. *Problem:* build giant tanks to store fuel deep in the ocean—light enough for towing, strong enough for long-term anchorage. *Solutions* under consideration: specially engineered fabrics.

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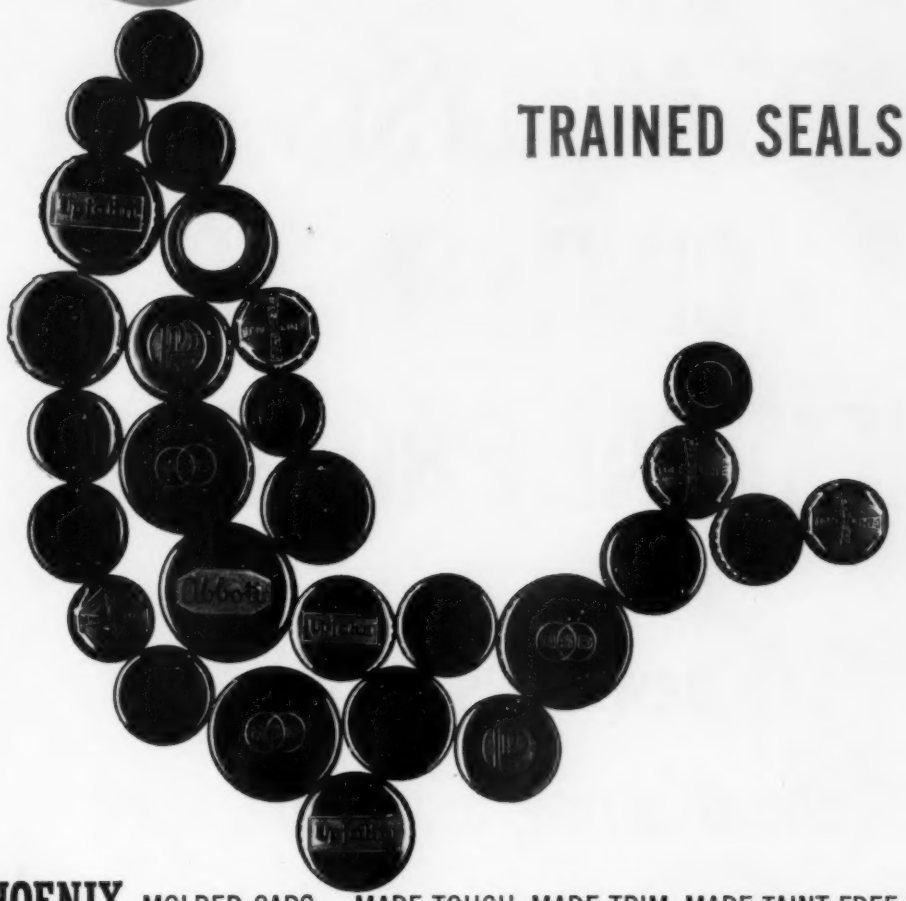

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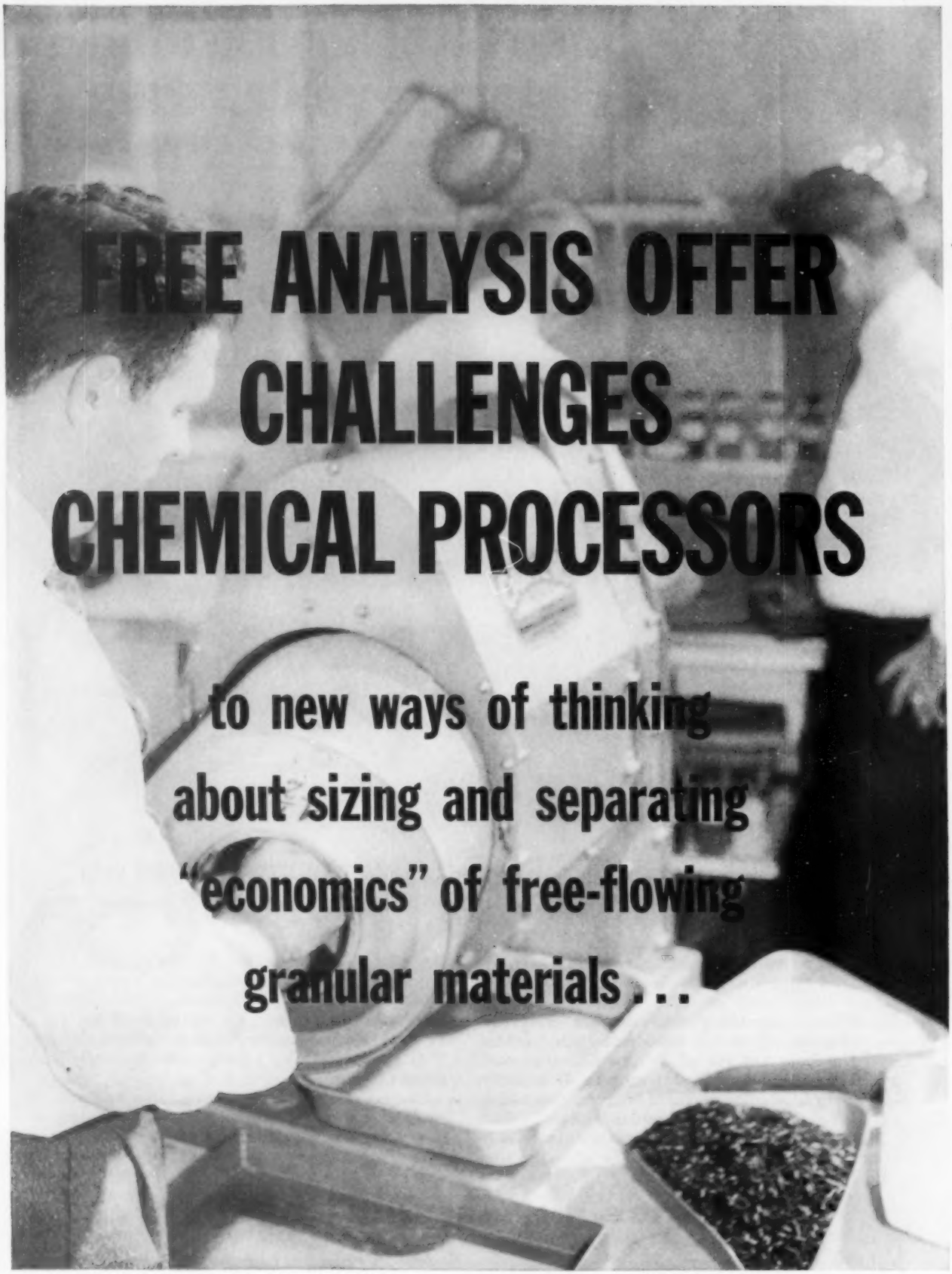
FREE ANALYSIS OFFER CHALLENGES CHEMICAL PROCESSORS
to new ways of thinking about sizing and separating "economics" of free-flowing granular materials . . .

SIMON-CARTER laboratory analysis shows how new rotary principle of separation provides profitable answers for processors!

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This small hand-driven Disc Separator model enables Simon-Carter technicans to duplicate length separations in miniature with only a small material sample supplied by the processor.

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Every month finds more compact, *rotary* Simon-Carter machines turning out impressive production records in the chemical industry. But we make our unique offer because we want *all* processors to know what significant "economies" *rotary* action can produce!

Do you have a problem removing agglomerates? Analysis may show

The material to be separated or sized is carefully examined under magnification to better fit tests and equipment to the problem.

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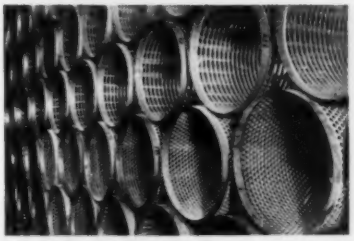
Or do you have a length separating problem? Simon-Carter technicians use test equipment that duplicates the *rotary* motion of the Simon-Carter Disc Separator. Rotating discs, each with thousands of precisely formed tiny pockets, select or reject materials by length with uncanny accuracy! We will experiment with different disc pocket sizes, operating speeds, output volumes, etc., to exactly fit your requirements!

Another important series of tests involve *width* and *thickness* sizing. The Simon-Carter Precision Grader does these jobs. We can duplicate its action on test equipment—experiment with up to 80 different cylinder perforations for you! There are many other tests and many other Simon-Carter machines like the Duo Aspirator, Sonic Conveying System and Spin-Away Centrifugal Dryer, that can be applied to solve your particular problems.



These are some of 80 different cylinders, each with different size perforations, that Simon-Carter can choose from to solve your width or thickness separating problems.

In addition to laboratory tests, Simon-Carter engineers will recommend ways to streamline *all* your separating and sizing functions—improve not just one processing step but the whole system! Through Simon-Carter's *free* analysis offer you can take a long stride forward in efficiency! Send in the coupon below for details today!

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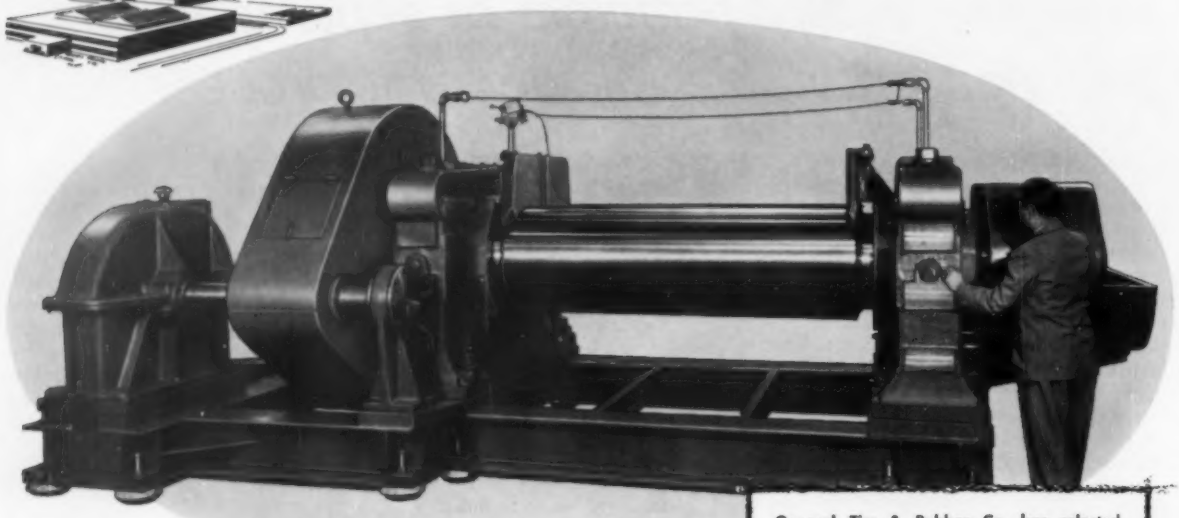

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The reason clearly is the often established superiority of our self-cleaning twin-screw design based on these features:

● **Color dispersion quality.** In low-melt viscosity thermoplastics, the shear action necessary for adequate pigment dispersion cannot be achieved with conventional screws due to high back flow. The forced flow in our twin screw machines with sealing profile allows to create in various zones exactly the required intensity and duration of shear corresponding to the material viscosity in each stage.

● **Devolatilization.** This is quite tricky with low viscosity materials due to the formation of films susceptible to gradual degradation on the unscraped surfaces of non self-cleaning machines. In Werner & Pfleiderer ZSK-machines, the self-cleaning action of the screws is maintained also in the decompression zones under the vacuum ports. Therefore no plugging-up of the vents will occur and the screw surfaces stay clean.

● **Clarity of material.** The average dwell time in a 3¼" diameter twin screw machine is, at an output rate of 330 lbs/h, only 55 sec., with the extremes ranging between 40 and 90 sec. For heat sensitive materials, one of the prime reasons for color development is thereby eliminated. Clarity can further be improved by feeding the material to the compounder with a slight moisture content. The evaporation of this moisture has a steam stripping effect, and at the same time permits to maintain a low and exact temperature level. This method can be applied in ZSK-machines since devolatilization in these machines is very easy and reliable.

● **Little production loss through down times. The self-cleaning action of the** screws permits color changes without dismantling the machine – just by feeding the new color – within ten minutes. ZSK machines can be started even when filled with material!

● **Any form of feed material. Pellets, beads, flakes or powders can all be fed to** ZSK-machines with reliable intake and uniform delivery rate

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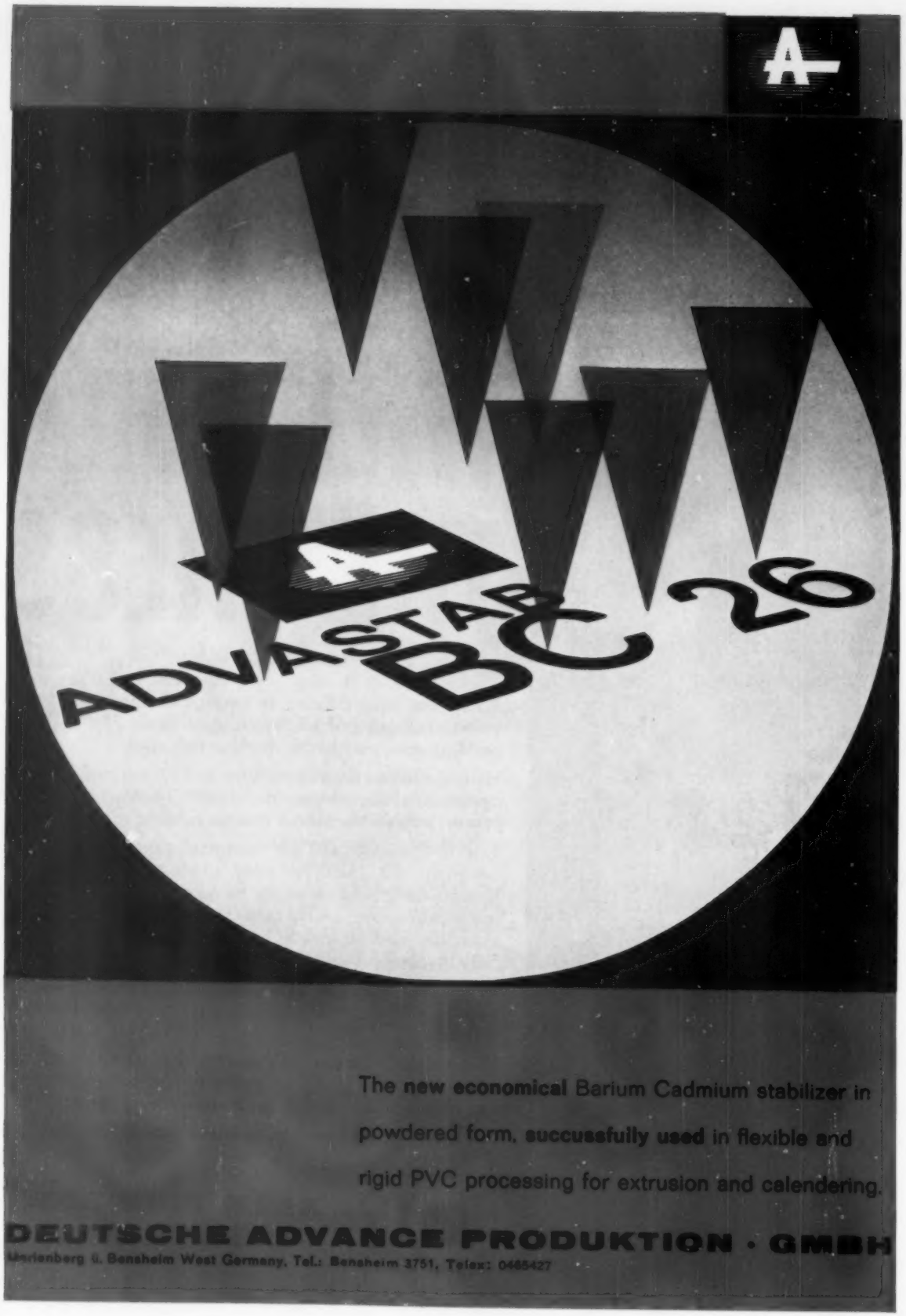
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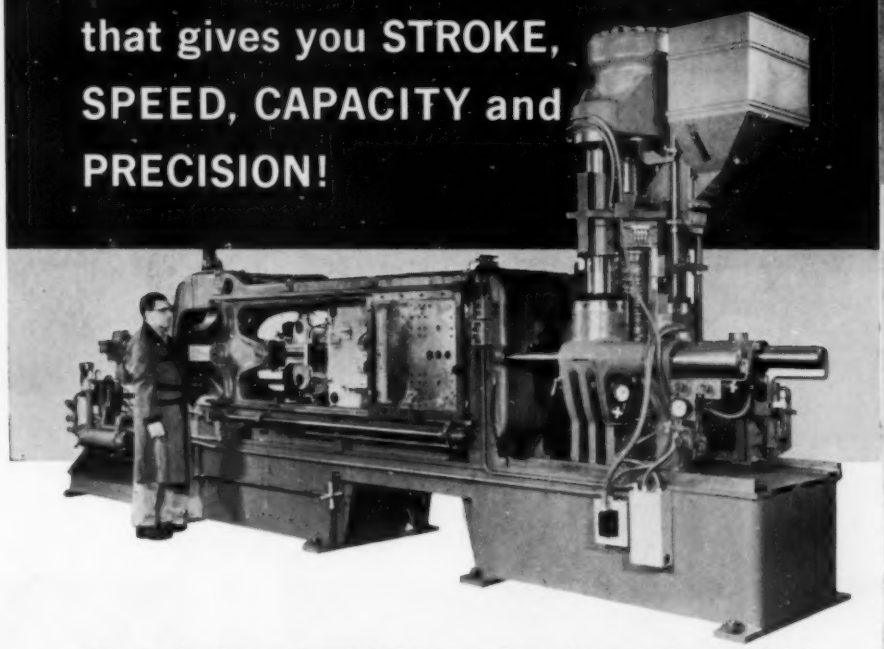

Here's why the new L-500-24/32 ounce Lester has won the unqualified approval of critical molders, who are using it to produce quality parts, such as those shown here. It has:

STROKE...a full 30″ of mold opening (adjustable by simple hand crank at the link cylinder to 8″). The maximum mold height of 30″ is conveniently and rapidly reduced to any dimension down to 9″ by use of the 3″ travel of the large central adjusting screw, in combination with standard 3″, 6″, and 9″ spacer rings.

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CAPACITY...the most fully proven, simplest, trouble-free cylinder in the industry, capable of plasticizing 300 pounds per hour of general purpose polystyrene. The advantages of the vertical injection system include retractability for easy purging and the famous, foolproof, Lester nylon cutoff attachment.

PRECISION...the one-piece cast-steel frame provides 500 tons of CERTIFIED clamp that cannot go out of adjustment. The fully supported movable platen is aligned with mold-maker's accuracy to assure flash-free parts and longer mold life.

The L-500-24/32 ounce Lester—the modern machine for modern materials—is producing profits for molders of housewares and lenses, toys and pipe fittings. It can do the same for you. Write for specifications.

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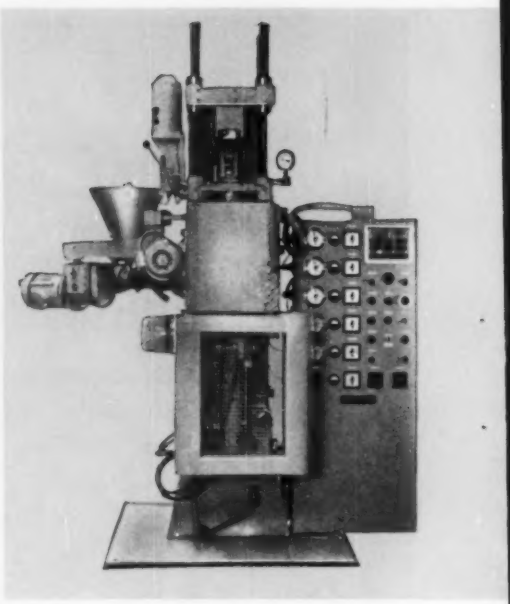

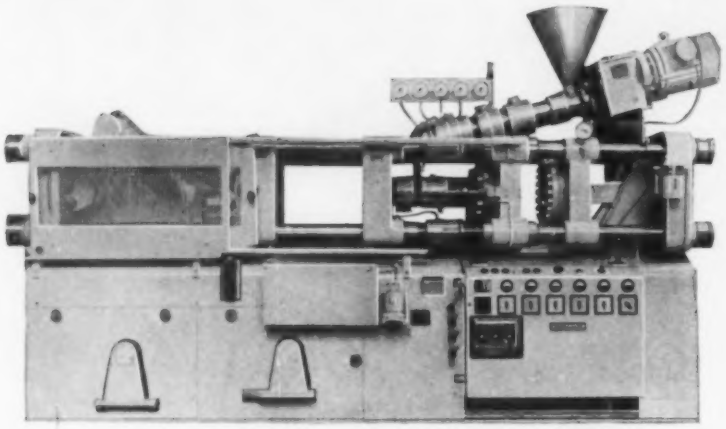

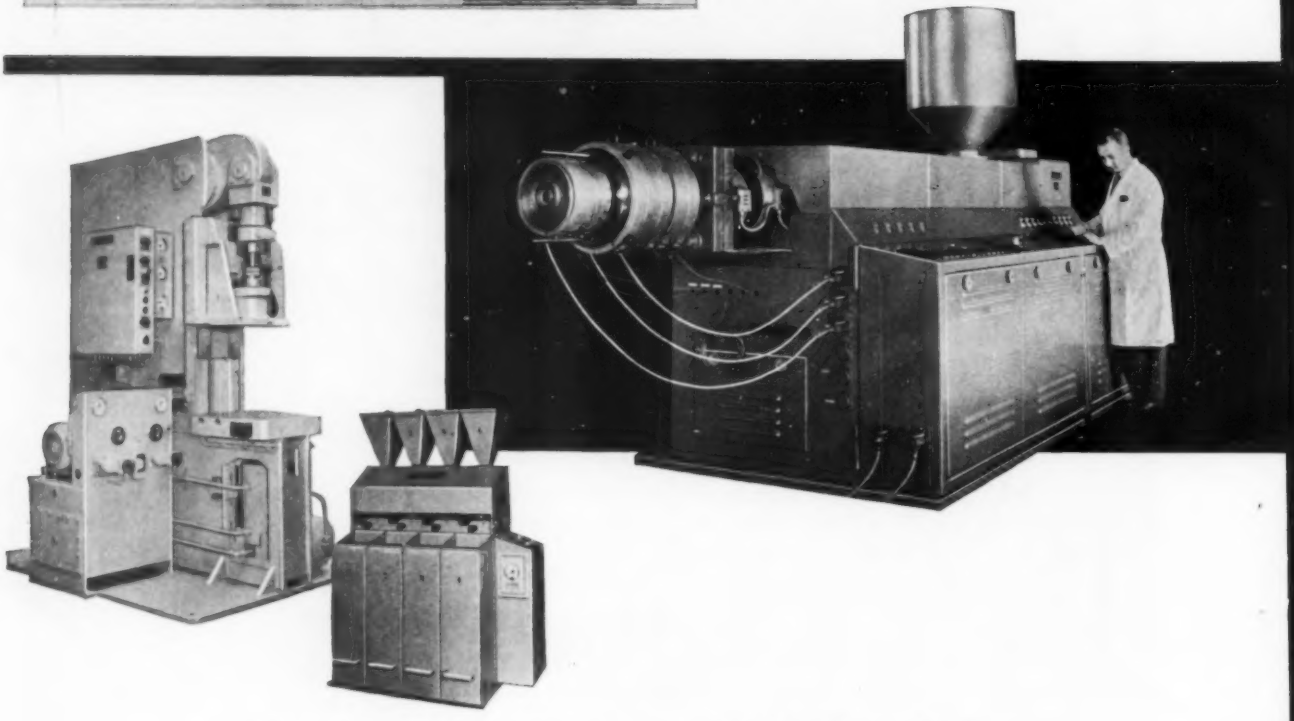

The progressive application of plastics in industry and trade requires efficient processing machines. Battenfeld automatic machines meet these requirements and impress by reliability and economical production. We are pleased to inform you of our manufacturing program and to assist you in solving all your production problems.

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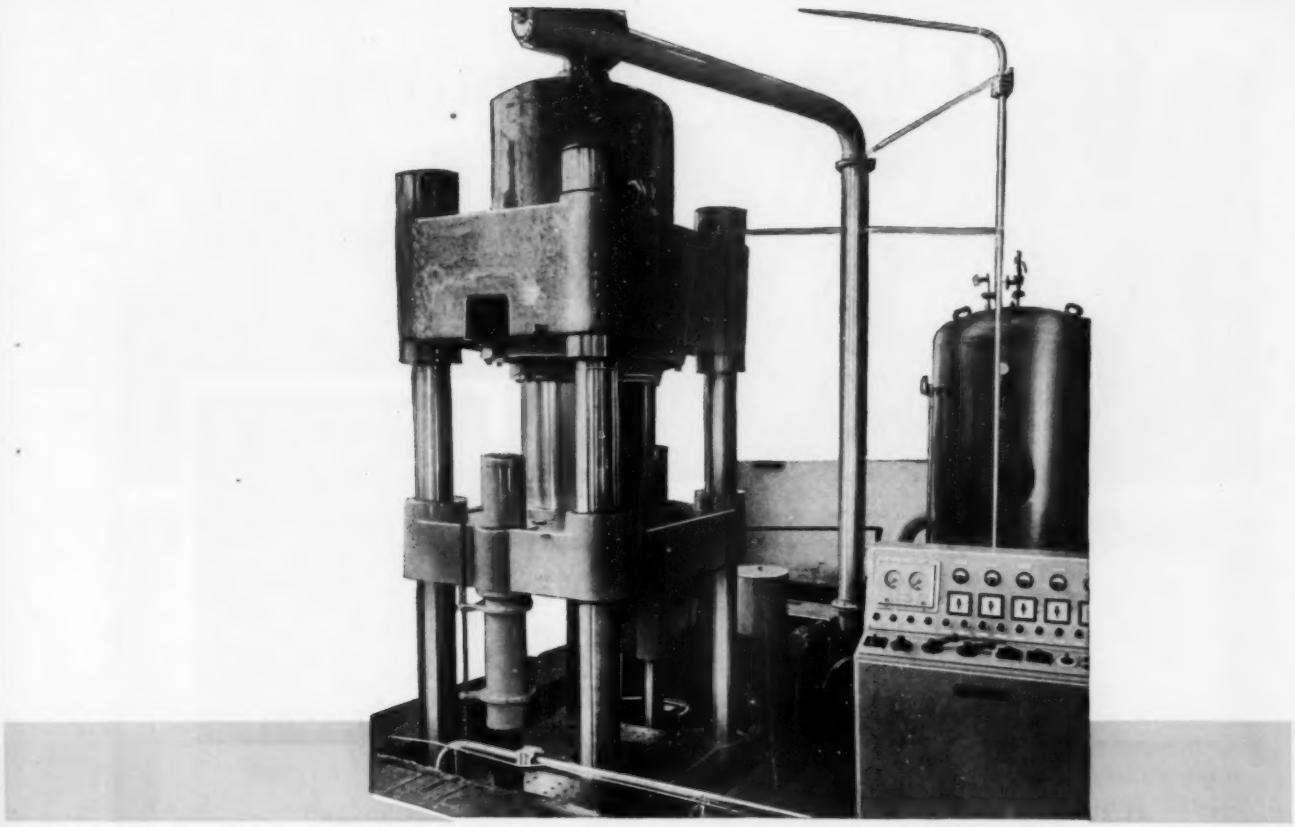

BATTENFELD

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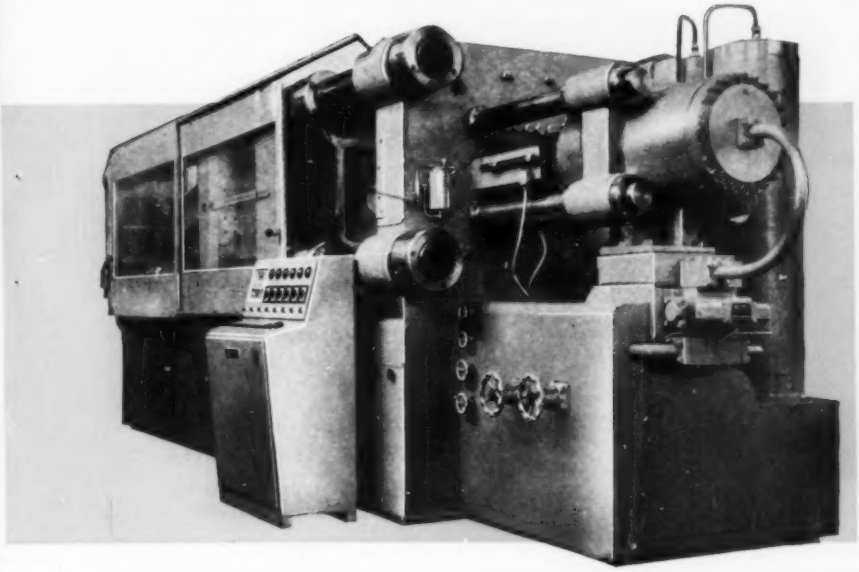

More than 7000 Battenfeld automatic injection molding machines are in operation in 67 countries all over the world. This figure evidences the confidences in our machines and is a proof for the capacity of our production plants.

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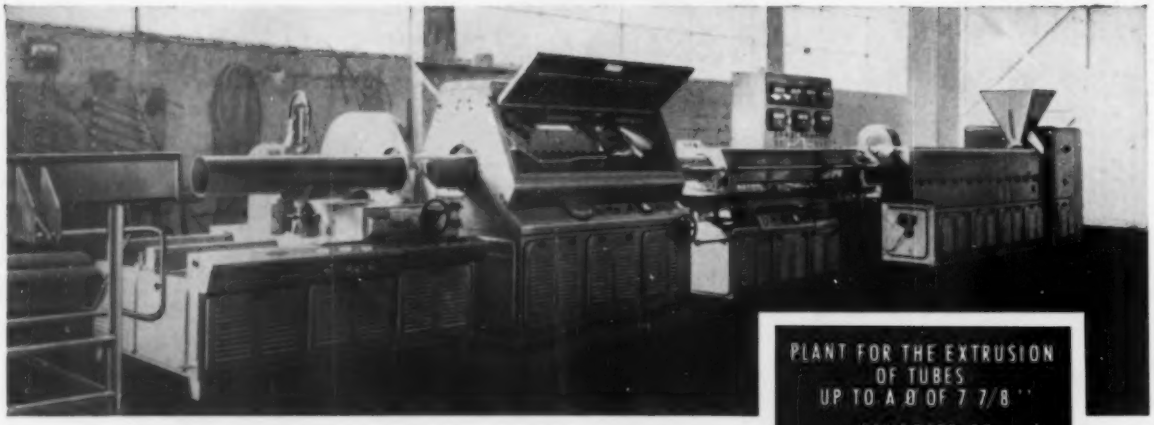

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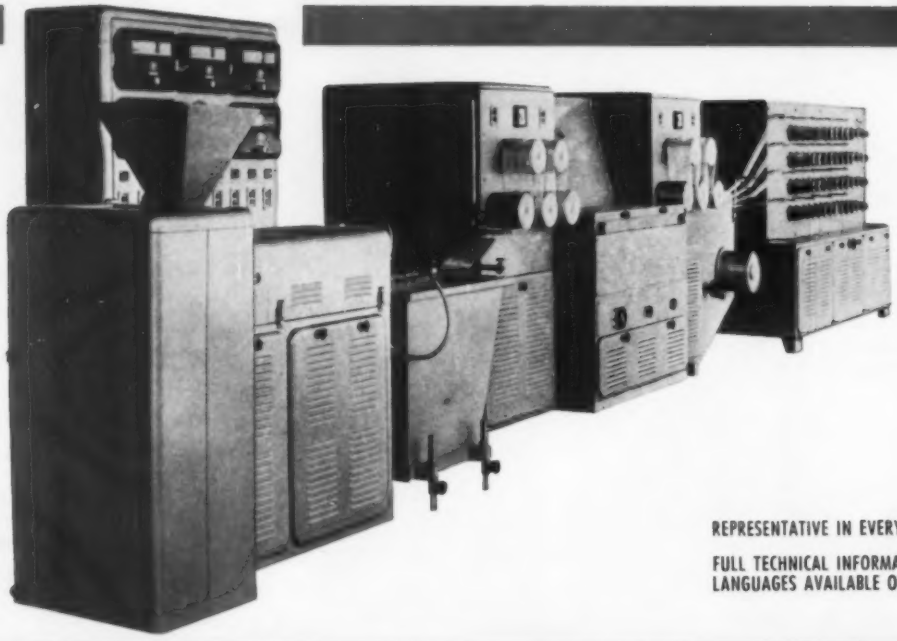

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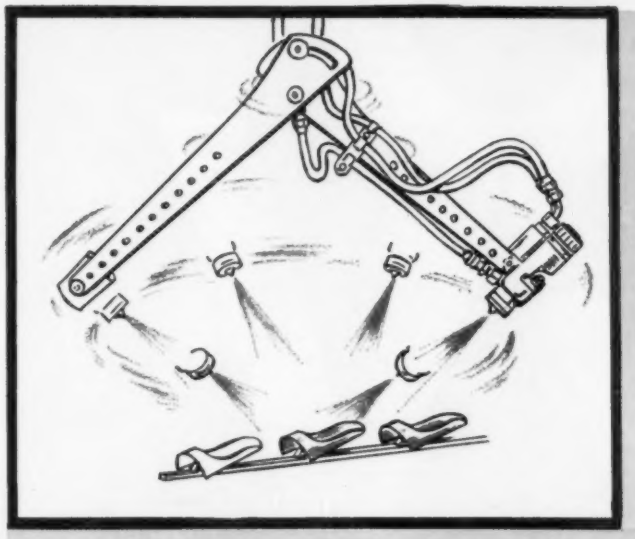

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Send for our new four-page brochure on the Rotomatic Coater.

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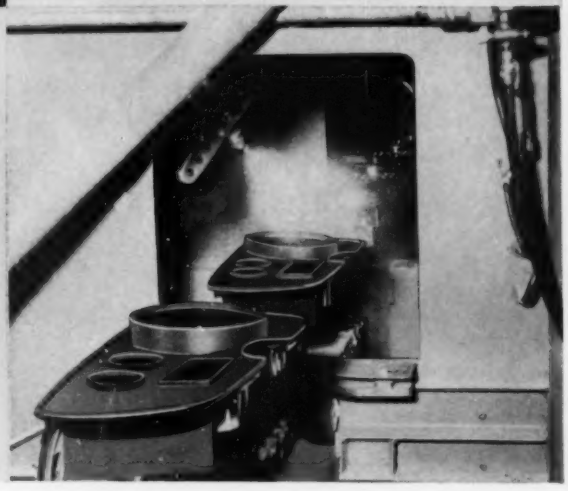

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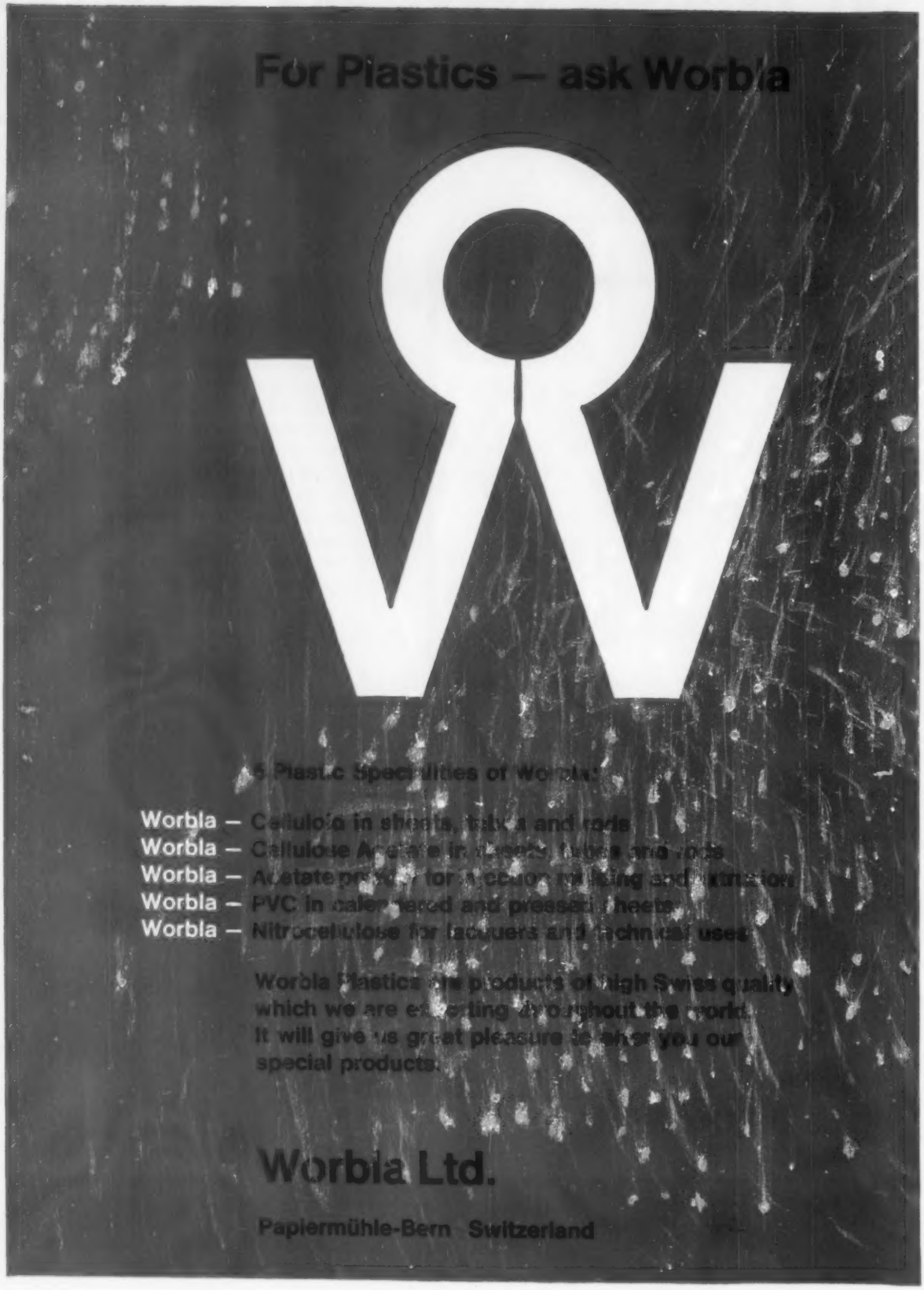
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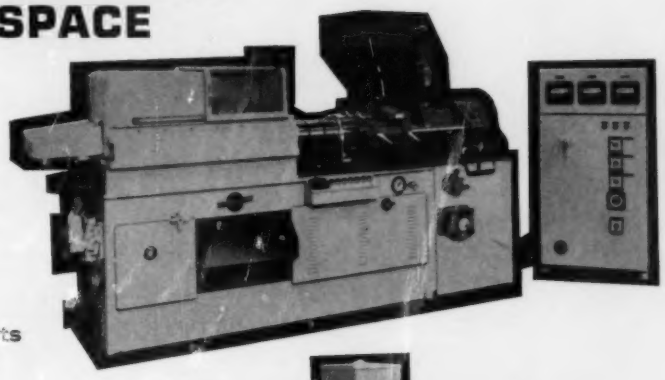
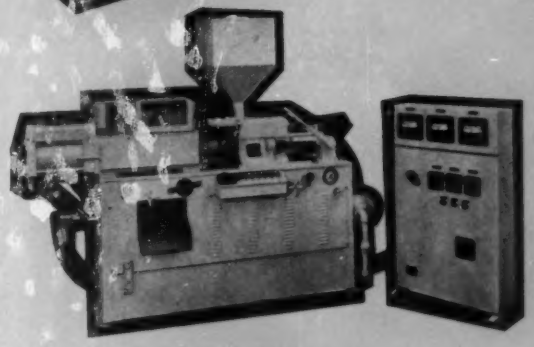


AUTOMOLDER*
MODEL KS6-100-50

The KS6-100-50 is a highly efficient screw plasticizing injection unit designed to handle critical materials and the newly developed thermo-plastics. A reciprocating screw acts as the injection ram and melt homogenizer producing better parts consistently. Moderately priced, this machine satisfies the needs of the progressive molder.

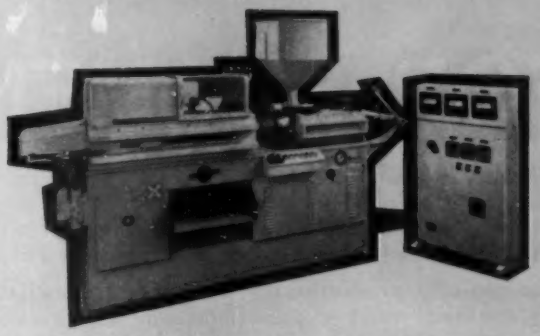
AUTOMOLDER*
MODEL K3-100-50

In this simply-designed, fully hydraulic machine there are features not found in other small molding machines. The K3-100-50 produces 1500 automatic cycles per hour with a clamping unit closing force of 100 tons. Being self-contained the K3-100-50 uses only 10' x 3' x 6' of floor space.



AUTOMOLDER*
MODEL K2-50-50

This is a smaller two ounce machine which may be electrically or cam operated. A unique sub-plate mounted valve system eliminates costly maintenance and offers easy access. The K2-50-50 offers production capacities for a minimum initial investment.



AUTOMOLDER*
MODEL K2-100-50

Another compactly-designed fully hydraulic injection molder from Standard's drawing board. Built on a solid weldment frame the K2-100-50 is a 100 ton clamp machine providing two ounce shot size and 2000 cycles per hour.

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THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 2 — December 1961

Girding for battle

A potential battle royal that should lead to a lot of fun, fight, and furor is shaping up in the plastics industry between various thermoplastics that sell for from 35 to 70 cents. Industry gives them the sophisticated name of "engineering plastics." This reporter has often called them the "tough-to-sell" resins. In general, they must be sold on a quality basis; there is scarcely a product application for which they contend that they must not prove better qualifications than lower-cost, big-volume resins and also that they are adequate to perform a job that might otherwise go to the even higher-priced super plastics, such as fluorocarbons.

The resins in this 35 to 75¢ price range are ABS (acrylonitrile-butadiene-styrene); styrene-acrylonitrile copolymers; the cellulosics (acetate, butyrate, propionate, and ethyl cellulose); and acetal and copolymers. Some polyolefins, such as polypropylene and certain grades of linear PE, are now in this area but are expected to be in lower price brackets before 1965. Methacrylate is in this price area, but in a separate category because of its superior clarity and weathering properties; modified, "impact" methacrylate is deeply involved and is rapidly taking over applications in the "engineering plastics" category (see cover story, p. 78).

Price reduction for ABS

One of the resins included above is Marbon Chemical's Cycolac ABS material. The price of this material has been reduced to 42¢ in natural, 46¢ in standard and custom colors, 49¢/lb. in metallics. The previous base price for natural was 49 cents. Other producers have also cut their prices to corresponding levels.

Marbon has been an energetic marketeer of this material since it entered the field six years ago, and uncovered various new areas for its application. However, the 49¢ price was sometimes a handicap to entering new fields. It is believed that the 42¢ price will broaden the market base. The move is also probably a recognition of the price struggle that has long been imminent in the area of "engineering plastics," an applications area which is being constantly stimulated by the ABS "fever" that has impregnated industry; by intensive promotion of other engineering plastics; and by indications that polypropylene producers are ready to go after various applications in this field. The ABS producers are looking particularly at the refrigeration field, where they hope to compete in various applications with a claim that they can use thinner walls to provide adequate impact strength.

Another significant move by Marbon was the introduction of a medium-impact resin of this type identified as Cycolon. It is described as a material designed to meet the need for a plastic with general ABS physical properties but with less impact strength than Cycolac. The price is approximately 9% lower than maximum-impact Cycolac grades. Suggested application areas are refrigeration, automotive, toys, display racks, seats, housewares, and radio or TV components. Its processing advantages are said to be high gloss, faster rates in injection molding, sheet forming, and sheet extrusion, and good dimensional control.

Another reinforcement of Marbon's position is the announcement of its

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RESEARCH REPORT

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intention to build a 75-million-lb. styrene monomer plant to supply styrene to the Marbon Cycolac plant in West Virginia, and to its Indiana facility, which manufactures high-styrene resins for reinforcing rubber. The new plant will be completed at Baytown, Texas, in early 1963.

Another new ABS plant!

About a month before the price drop in ABS, B. F. Goodrich Chemical Co. emphasized its entrance into the field with an announcement that it had completed a new plant for ABS resin (Abson), at its Louisville, Ky., manufacturing site. The company's first ABS facility was completed at Akron, Ohio, in 1960. No capacity figures for the new plant were given. The company will provide four compounds for extrusion and molding with varying properties.

The amount of ABS materials that will be used in 1961 varies, according to whom the estimator may be, from 70 to 90 million pounds. Seventy million is the figure generally used for 1960.

New variations in polyester film

Several new types of Du Pont's Mylar film recently placed on the market have been attracting attention. One is ½-mil polymer-coated Mylar M-26 used in a "make and fill" operation—that is, the bag is manufactured and dump filled in a single-line operation. It is said to be the first time a single-wall bag can be loaded with up to 2 lb. of weight. It is expected to supersede a double-wall, coated cellophane bag. The first large application for the coated new film is this year's Sun-Sweet growers' prune crop. The film costs approximately the same as its predecessor and gives increased seal strength, better durability with longer flex life, and unlimited shelf life—which is particularly essential for dried prunes.

Another new type is Mylar M-25, an improved form of polymer-coated film for packaging with inert gas or vacuum. It gives better forming properties, deeper draw, greater durability. When made into bags at the plant, it gives from two weeks to a month's shelf life to such products as luncheon meats, thus permitting packaged shipments straight from the packer to retailer, eliminating the need for repacking in the supermarket.

The third new Mylar is a 14-gage film, the thickest of a range which now extends from ¼-mil. The new film is used primarily in wedge insulation in hermetic motors, slot liners, and other electrical applications. Non-electrical uses are apparel stays and stiffeners, "credit card" and other plastics laminations, fiberboard surfacing, and stencils.

A wrapper for lettuce

For many years the plastics industry has been trying to find a satisfactory film for wrapping lettuce—especially one that would be satisfactory for packaging in the field. Among manifold problems, a major one was that lettuce leaves would turn brown during shipment, generally because of improper "breathing" of the film. The Dobeckmun Co., division of The Dow Chemical Co., now states that it has a new film that will permit shipment of wrapped heads of lettuce directly from field to store, from California to New York if necessary. Among other advantages, this will obviate the need for trimming and wrapping of lettuce at store level before

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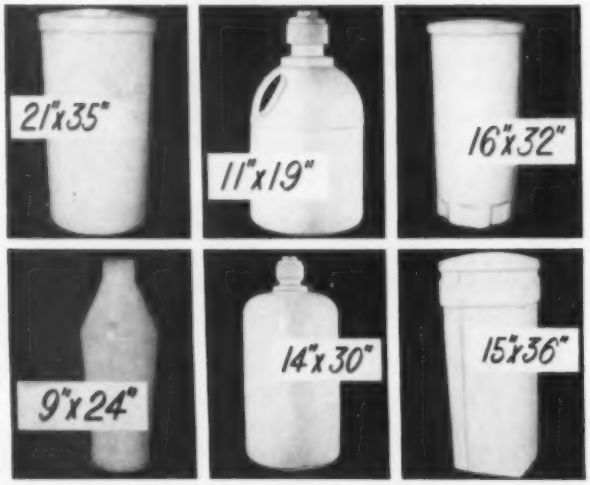

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it is displayed, and will also permit more uniform quality of a complete shipment.

The film is Dow's shrinkable Trycite polystyrene. For the lettuce wrapping, machinery, including conveyor belts, is set up in the fields so that each head is wrapped within seconds of cutting and trimming. Wrapped heads are in the heating tunnel for only 2 sec., where they are subjected to a heat of 280° F. The seal of the overwrapping is effected on a hot plate operated at 250 to 260° F. The "breathing" nature of the film allows a proper combination of transmission rates of oxygen, carbon dioxide, and moisture vapor. In themselves, the film's transmission rates for the two gases are no better than those of polyethylene film, for example. But these rates combined with a moisture-vapor-transmission rate of 6 makes the film satisfactory. In shrinking, the film is not drawn too tightly to the lettuce head, but produces a semi-stiff protective "shell" and a minimum of surface-to-surface contact between film and lettuce. The packaging is done in the California lettuce fields by the Budd Antle packaging system.

It is estimated that the potential market, or at least the "target" market, for film in lettuce wrapping is around $10 million per year.

Improved PP film by AviSun

AviSun Corp. has announced a new high-slip PP film designed for high-speed packaging machines. A spokesman said that the new Olefane A-3 can be used on many different types of machines: form-fill-seal, back seam, and side-weld baggers. It is the beginning wedge in an effort to capture a good portion of the bag market, which up to now had been a questionable area for PP film because of difficulty in sticking, cutting, and sealing. As reported in the final article of our series on PP (page 87 of this issue), heretofore most PP film has been used for flat and shrink wrapping.

New markets for PVC

For some unbelievable reason there are various "authorities" (mostly market researchers) who preach that vinyl chloride resins have reached their peak growth. Yet it is possible that 1961 will show a 40-million-lb. growth—not as much as the 100 million lb. more or less expected in PS and PE, but a sizable growth and enough to put vinyl chloride totals close to the 950-million-lb. mark.

An interesting aspect of vinyl's growth is its great variety of end-uses. Many of them consume less than 100,000 lb. a year—many others only from 1 to 10 million lb.—but the sum total of all so-called small usage is probably well over 100 million pounds.

Among these items is B. F. Goodrich Co.'s Koroseal magnetic strip (see MPI, Nov., p. 239). In addition to refrigerator and other appliance applications, it is already being used in pocketbooks to supplant a latch, and in displays to adhere papers or light weight products to metal surfaces. On a storm window assembly, it holds the screen and window taut to the frame to eliminate drafts. The strip may even be used on automobile doors. A coming adaptation is the use of magnetic vinyl powder in shoe soling to give sure-footedness on metal.

Vinyl for shoes

Goodyear Tire & Rubber reports that its Shoe Products division is rapidly expanding its line of vinyl soles and heels. The soling, since it can be either stitched or

TITANOX®-RA-40 belongs in this picture...

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cemented to uppers, offers a vinyl bottom for shoes made by conventional methods; but it is especially suitable for children's shoes—where it will outwear the uppers. For men's shoes, vinyl toplifts are increasing in popularity—they resist spreading, are non-marking and lightweight. Goodyear is introducing a one-piece vinyl sole and heel called Vinabond. One interesting factor in this announced market expansion is that vinyl has taken so long in coming into its own in this application. Shoe soles and heels were among the earliest vinyl products developed, and were widely used by the Germans in World War II. However, it has been difficult to overcome cold-temperature cracking and other problems which Goodyear claims have now been satisfactorily overcome.

Foreign countries have reported various degrees of success with vinyl shoe materials for several years, but there has never been unanimity of opinion. A correspondent from Australia writes that our report from that country was exaggerated—that only 1500 tons of PVC were used there in 1959 instead of the 2000 tons originally stated. Furthermore, he says that the market shrunk by 500 to 800 tons in 1960 and has been much lower in 1961, due to merchandising problems and a campaign against vinyl shoes staged by the leather footwear association.

Will plastics hold up in a building?

Monsanto Chemical built a laboratory four years ago and used as much plastics material as was then available from current sources.

In a recent talk before the Building Research Institute, Albert Cleneay of Monsanto told how these materials had performed. Here are a few of the highlights. More details will follow later:

Many problems that were encountered were traced to faulty installation work. Once this was corrected, the plastics materials performed satisfactorily. Of the rigid vinyl pipe installed, 99% is still in operation. Temperature limitations for fluids piped were held to 120° F. Methacrylate window louvres are still in excellent condition with almost no scratches and no weathering. Reinforced plastic exterior sandwich panels with foam cores are now as good as ever, with scarcely noticeable discoloration. Exterior concrete blocks faced with polyester-sand aggregate are somewhat discolored, but blocks used in interior applications (*e.g.,* rest rooms, stair wells, corridors, etc.) are still in perfect shape—one of most successful of all applications. Monsanto is now using them in much new construction. PE sheeting used below floor slabs as a moisture barrier has proved very successful.

Azelate plasticizers at lower price level

A new price level, the lowest in 17 years, for azelate plasticizers has been initiated by Emery Industries Inc. Azelates have long been noted as plasticizers that give superior low-temperature performance to vinyl chloride film or sheet for use in automotive or furniture upholstery and outerwear. Furthermore, they give soft "hand" and low volatility. However, they are more costly than general-purpose plasticizers and heretofore have been used sparingly; the new price should encourage greater consumption. The price of Emery's Plastolein azelates, which was reduced early in 1961, has again tumbled; the range now extends from 35¢ to 45¢/lb. with current reductions ranging from 1 to 2 cents. It is believed that the new price, especially that 35¢ item which was at one time up in the 40's, will make the azelates more attractive to producers of a wide range of vinyl products.

For additional and more detailed news see Section 2, starting on p. 208

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*

Blown tubing take-off unit

These blown film take-off units have a roller-type tent assembly for collapsing the film and provisions for making plain, gusseted, or slit tubing with precision folds and absence of wrinkles. Large-diameter (6 in. for widths up to 72 in.; 8 in. for widths up to 96 in.; 12 in. for widths above 96 in.) nip rolls provide for constant web tension. New, improved, motorized, high-speed rotary film slitters are used. Dual-turret winders are powered by a variable-speed drive (0 to 180 ft./min.) for high-speed roll change-overs. A special winding system is provided. Units having widths of 24, 36, 48, 60, and 72 in. are standard; special units up to 130 in. wide are available. *Sterling Extruder Corp., 1537 W. Elizabeth Ave., Linden, N. J.*

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

Small thermoformer

This push button-controlled laboratory pressure forming machine, Model P-88, is designed for short-run production and development work to determine the formability of new plastics and products. Working area is 8 in. square. Parts up to 4 in. deep can be made using temperatures up to 600° F. Maximum platen stroke is 5 inches. Cycle is semi-automatic. Unit is heavily constructed for durability and requires a floor space measuring only 24 by 36 inches. *Plastics Machinery Div., The Producto Machine Co., 990 Housatonic Ave., Bridgeport 1, Conn.*

Four web slitters

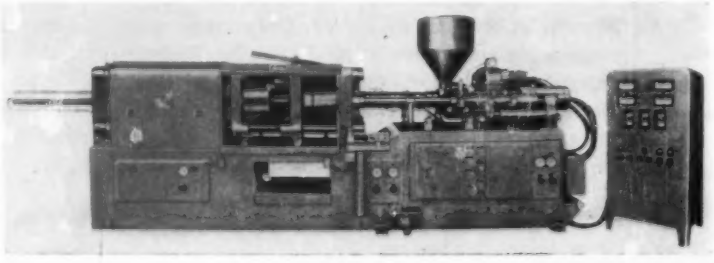
Four improved models of Hobbs web slitters are now available. Model A is a general-purpose machine suitable for score or shear cutting on materials, such as plastic-coated paper, but is not recommended for delicate plastic film. Speed range is up to 500 ft./min. and width ranges are 40, 50, 60, and 72 in., plus special widths on custom units. Model B, a variation of Model A, is designed especially for use on materials wound with individual tension on rewound webs or reels. Infinitely variable drive gives speeds up to 500 ft./min. with widths as above. Model C is designed for use with non-woven materials, such as fibrous glass mats, which are to be slit into reels for use in reinforced plastics. A.c. or d.c. powered, speed ranges up to 300 ft./min. Web tension is controlled by Hobbs CHP winders and widths range from 40 to 84 inches. Model MDH is a high-speed slitter with a choice of score, razor, or shear cutting heads. Production speeds are 1000 to 1500 ft./min., depending on material slit. Widths of 50, 60, and 70 in. are available. *Hobbs Mfg. Co., 26 Salisbury St., Worcester, Mass.*

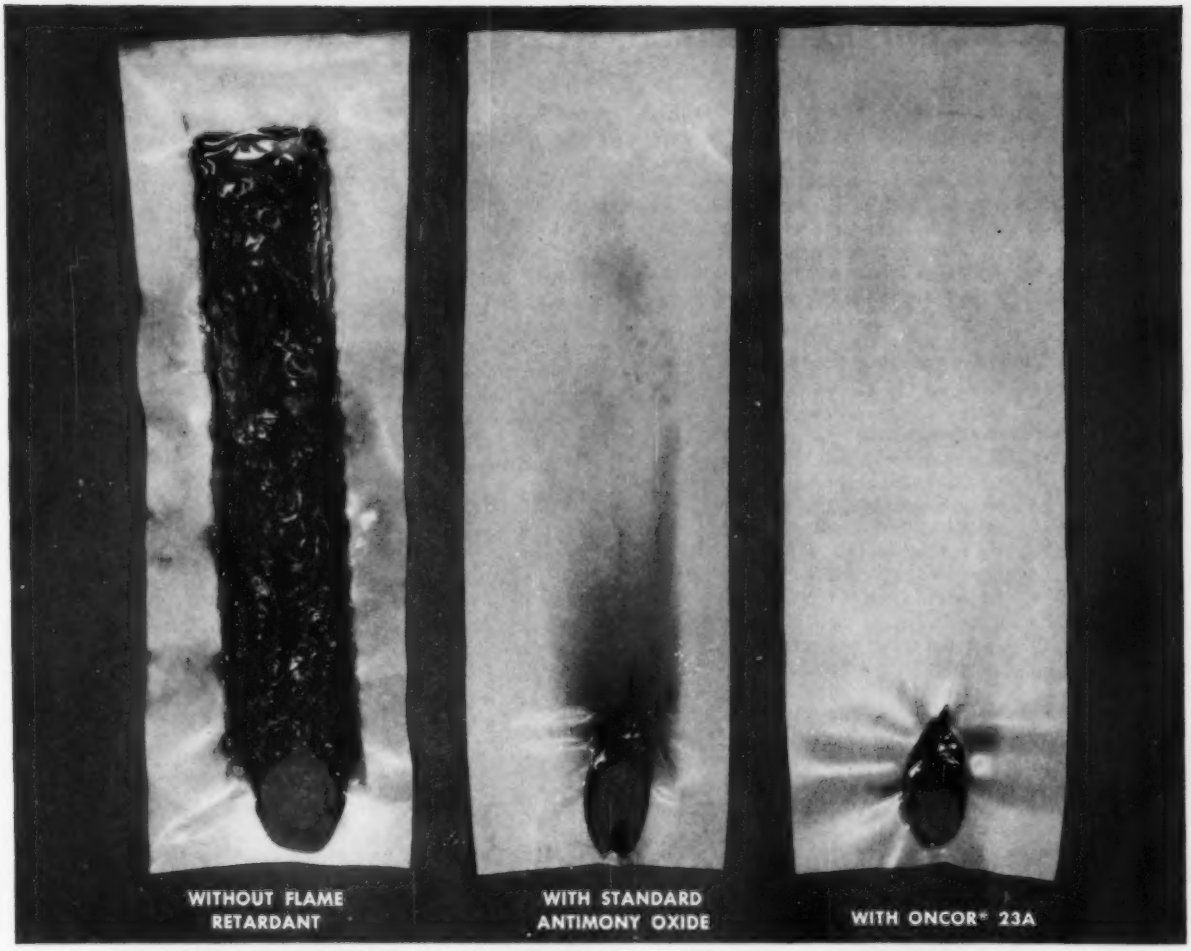
Plastic dispersion pump

This pump is designed for feeding and recirculating sensitive coating formulations between the shipping drum and the process equipment feed tank or hopper. A wide range of dispersions can be handled, but the pump was especially designed to handle plastisols or PVC dispersions. The unit is designed to operate with its inlet submerged

Reciprocating-screen injection machines

Americanized Stübbe, German reciprocating-screw injection machines are now available from Modern Plastics Machinery Corp., which has been granted U. S. sales and service rights. Models are equipped with Wheelco heat controllers, Vickers hydraulic power units, and heavy-duty U. S. Electric motors. In addition, die platens are furnished with UNC American standard threads, as are the injection nozzles. The machines are available in models having plasticating capacities up to 190 lb./hr.; shot capacities up to 64 oz.; and clamp units up to a capacity of 500 tons. Typical cycles range from 2 to 24 cycles/min., depending on part and material. Machines are suitable for use with essentially all thermoplastics, including rigid PVC. Spare parts will be stocked by the domestic agent. Machines made by *Albert Stübbe, Maschinenfabrik, Vlotho/Weser-Kalldorf, Germany. Sole U. S. Agents are Injection Molding Machine Div., Modern Plastic Machinery Corp., 64 Lakeview Ave., Clifton, N. J.*





Typical results of recent flammability tests on 6 mil PVC film, following ASTM Method D 1433-56T. Antimony oxide and ONCOR 23A used at 5% level (resin basis)

Tests show effectiveness of

Oncor* 23A pigment...the cost-saving flame retardant for chlorinated-resin compounds

Effective, uniform flame retardance—the basic function of ONCOR* 23A—is combined with three important processing advantages that can add up to substantial economies in electrical insulation, paints, vinyl films or dipping plastisols.

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to avoid foaming the dispersion and is designed with special inlet section which starts the inlet stream rotating before it is handled by the main impeller. This results in a gentle pumping action to preserve the quality of the dispersion. Unit is supplied with a 350- to 1750-r.p.m. variable-speed drive controlled by a hand wheel and indicator. Pump weight of 200 lb. makes it reasonably portable. *Made by Bachofen-Meier Machinery Works, Bulach, Switzerland. U. S. Agent: Armstrong Machine Co., 958 Bellevue Ave., Syracuse 4, N. Y.*

Insert feeding and anchoring machine

Designed for use with the manufacturer's expansion inserts, the Dodge insert feeding and anchoring machine is a bench unit which consists of a vibratory-feed hopper, an orienting unit, an air-operated punch and sleeve assembly, and stand. The unit will position, drive, and anchor the insert in molded or drilled holes in the plastic part at rates up to 60 inserts/min., using a single-punch unit. Where more than one insert per part is required, the machine may be modified to handle several inserts simultaneously. The basic machine may be adjusted to handle various sizes of inserts. With proper auxiliary controls, the unit is adaptable to completely automated insert work. Basic unit requires a compressed air supply and 110 v. electrical supply. *Phelps Mfg. Div., Heli-Coil Corp., Danbury, Conn.*

Film cutter

This knife cutter is designed for use in pneumatic conveying lines such as those used to take away and regrind film trim on extrusion lines. It will handle films with a thickness down to 1 mil. The unit is small enough (8 by 6 in.) for convenient installation in almost any position in the line. Noise is claimed negligible. The grinder has an adjustable bed knife, inspection panel, and outboard anti-friction bearings. The top cover may be removed so that knives may be sharpened easily. The cutter may be used on any pneumatic conveying lines from 2 to 8 in. in diameter. *Sprout, Waldron & Co. Inc., 130 Logan St., Muncy, Pa.*

Mold fluid circulator

This insulated tank, high-heat circulator has been redesigned for maintaining injection molds at temperatures from 200 to 350° F. The improved model has a relocated 23 g.p.m. pump and Partlow controller with a top setting of 400° F.; heating capacity has been increased from 3000 to 9000 watts. A 4-in. dial thermometer monitors the temperature. Unit is designed for use with non-carbonizing heat transfer fluid, which sells for $35.50 in 5-gal. containers. The mold fluid control unit is sold from stock at a price of $689.50. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*

Two-roll mills

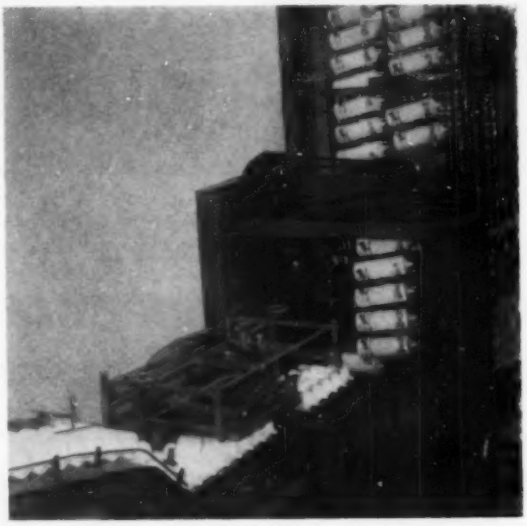
For plastic mixing and compounding operations, this line of two-roll mills is being offered in standard roll sizes ranging from 2½ (diameter) by 7 in. (length) to 10 by 24 inches. Models feature all-steel construction, large fully lined bronze bearings, wide-face gearing, chrome-plated rolls, oil seals, flood lubrication, hinged guides, totally enclosed fan-cooled gear-head motor, electrical safety brake, as well as magnetic starter. *Rubber & Plastic Machinery Co. of New Jersey, P. O. Box 1543, Trenton, N. J.*

Static neutralizer

The Takk Air Bar Static Eliminator supplies a static-neutralizing air stream up to 3 ft. in depth. The unit consists of air emission tubes coupled to an eliminator bar. The bar supplies a high concentration of ions through use of a patented "controlled diffused discharge" principle. Volume of ionized air is controlled by a valve. The de-staticizing units are supplied in lengths up to 120 inches. Several bars may be operated from a single standard power unit. *The Takk Corp., Newark, Ohio.*

Automatic bottle decorator

This silk screen bottle printing system will handle up to 60 bottles/min. and is completely automated, requiring only the loading of bottles at one end of the unit and their removal at the other. After being loaded into a chute, the bottle is automatically indexed in the silk screening machine, inflated with air for rigidity for printing, silk screened, automatically loaded onto holding pegs for drying in the oven, conveyed through the oven, and automatically ejected off the peg. The special oven conveyor is designed to keep bottles apart to prevent ink smudging and to provide up to 20 min. residence heating time at the maximum rate of 60 bottles per minute. The system of printer and oven will handle plastic bottles up to 11 in. long and with diameters up to 3¾ inches. Hot-air oven is indirect gas-heated and 3 ft. wide, 13 ft. high, and only 18 ft. long. Oven has a cooling section to cool bottles prior to ejection. Oven and printing units can be purchased separately. *American Production Machine Co., 109-35th St., Union City, N. J.*



Vacuum metallizer

Three major design changes have been made in the Stokes Model 427-6, 72-in. vacuum metallizing system. The planetary work carriage is now of heavier construc-

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For Wire and Cable Coating FROM DRYBLEND

The process of extruding plasticized PVC from dryblend has proven very successful with the PRODEX Mixer and Extruder combination.

Even formulae containing polymeric plasticizers exclusively and large amounts of filler are easily processed from dryblend on this equipment.

It has now found wide acclaim, both here and abroad, in the wire and cable industry where the advantages of dryblend instead of compounds are

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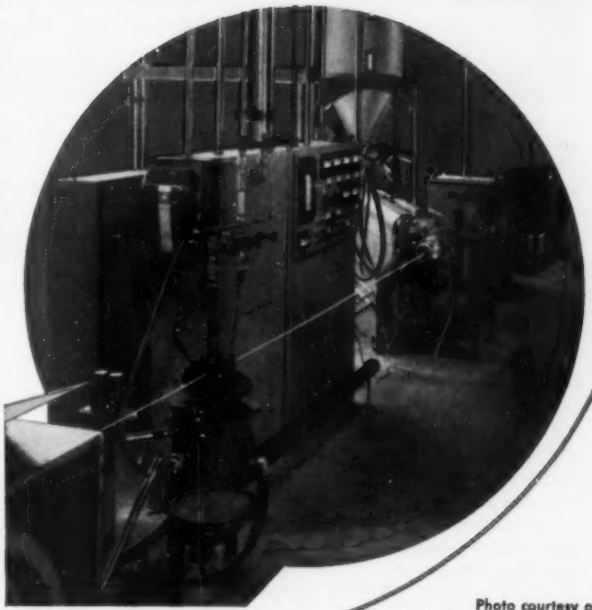

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Triangle Conduit & Cable Co., Inc.

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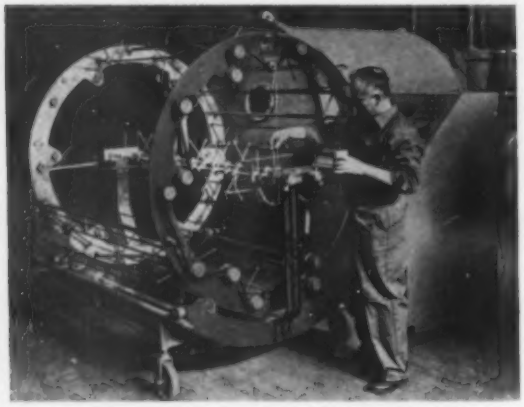
tion and will handle an increased work load of 10 reels of 16-in.-diameter (2 in. over the previous model), each with a working length of 54 inches. Faster metal evaporation is provided by a new type of power supply which has a 30-k.v.a. capacity. The vacuum pumping system now incorporates a single Model 1711 mechanical booster pump, backing up two 16-in. oil diffusion pumps. This



provides larger capacities in the higher pressure range, for example, over 1000 c.f.m. at 10 mm. of mercury. Results are faster roughing, no pressure surges when firing, and better performance on humid days. Interlocks provide proper cycling sequence. Automatic cross-over from rough to fine pumping, and automatic or manual control of firing are standard. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Hot stamper

This rotary-roll marking machine is designed especially for the marking or banding of plastic containers and can be used to apply practically any color in satin or glossy finish, either as a coating or as a color-filled indentation. An air-operated work table presses the work piece against the color foil and heated roller-shaped die. An air- operated head rotates the work, while an hydraulic checking device provides for smooth rotation and control of infinitely variable speed. Main spindle has a cartridge-type heater controlled by a thermostat. Foil is power-fed and synchronized with the rotary marking motion; foil indexes to fresh area on next cycle. Cycle is semiautomatic; after manual loading and activation, cycle is automatic. *Noble & Westbrook Mfg. Co., E. Hartford, Conn.*

Glass chopper

Low cost without compromises on size or output and easily replaceable cutting blades are the major improvements in this new fibrous glass strand cutter. Typical production rate is 7 lb./hr. of chopped glass fibers using three-strand feed and maximum air pressure. Blades are replaceable in the cutting head by simply removing one nut. Uses conventional operating principle of breaking the strands against a rubber roller. Price: $295. F.O.B. Mfr. *Fabricating Systems Inc., Bldg. 48, Hingham Industrial Center, Hingham, Mass.*

Plastic welding accessory

The Model KGS inert gas and air selector unit is used with hot-gas plastic welding equipment. A pressure-sensitive switch protects welding tool heater burn-outs by turning off heater power when welding gas pressure drops below 10 p.s.i. The selectors may be used with two welding tools at the same time; one can operate with either inert gas or compressed air, while the other operates on compressed air. This eliminates the waste of expensive inert gas when it is not needed. The unit consists of a three-way solenoid valve, power switch, safety switch on electrical welder power receptacles, compressed air pressure regulator (set to 30 p.s.i.), and air and gas inlet and outlet connections. *Kamweld Products Co., 932R Washington St., Norwood, Mass.*

New guide pin design for molds

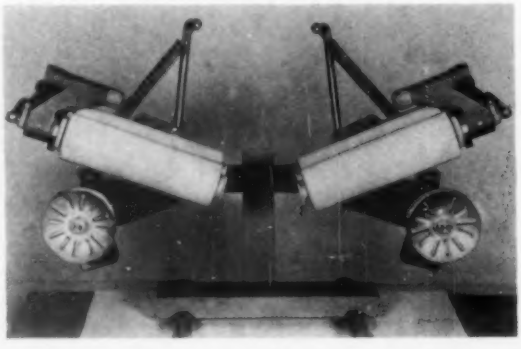
This standard shoulder leader pin has been designed with a major outer diameter which matches the outer diameter of the standard D-M-E shoulder bushings. This results in the use of a bushing with a $\frac{5}{16}$-in. wall thickness, increasing the strength of the design by about 50 percent. Since the pin's shoulder diameter matches the outer diameter of the bushing exactly, holes in the mold for pin and bushing can be bored simultaneously to insure more accurate alignment between mating pins and bushings. The ground and hardened pins are supplied in 1- and 1¼-in. diameters in several lengths to suit a variety of mold plates. *D-M-E Corp., Subs. of VoiShan Industries Inc., 6686 E. McNichols Rd., Detroit 12, Mich.*

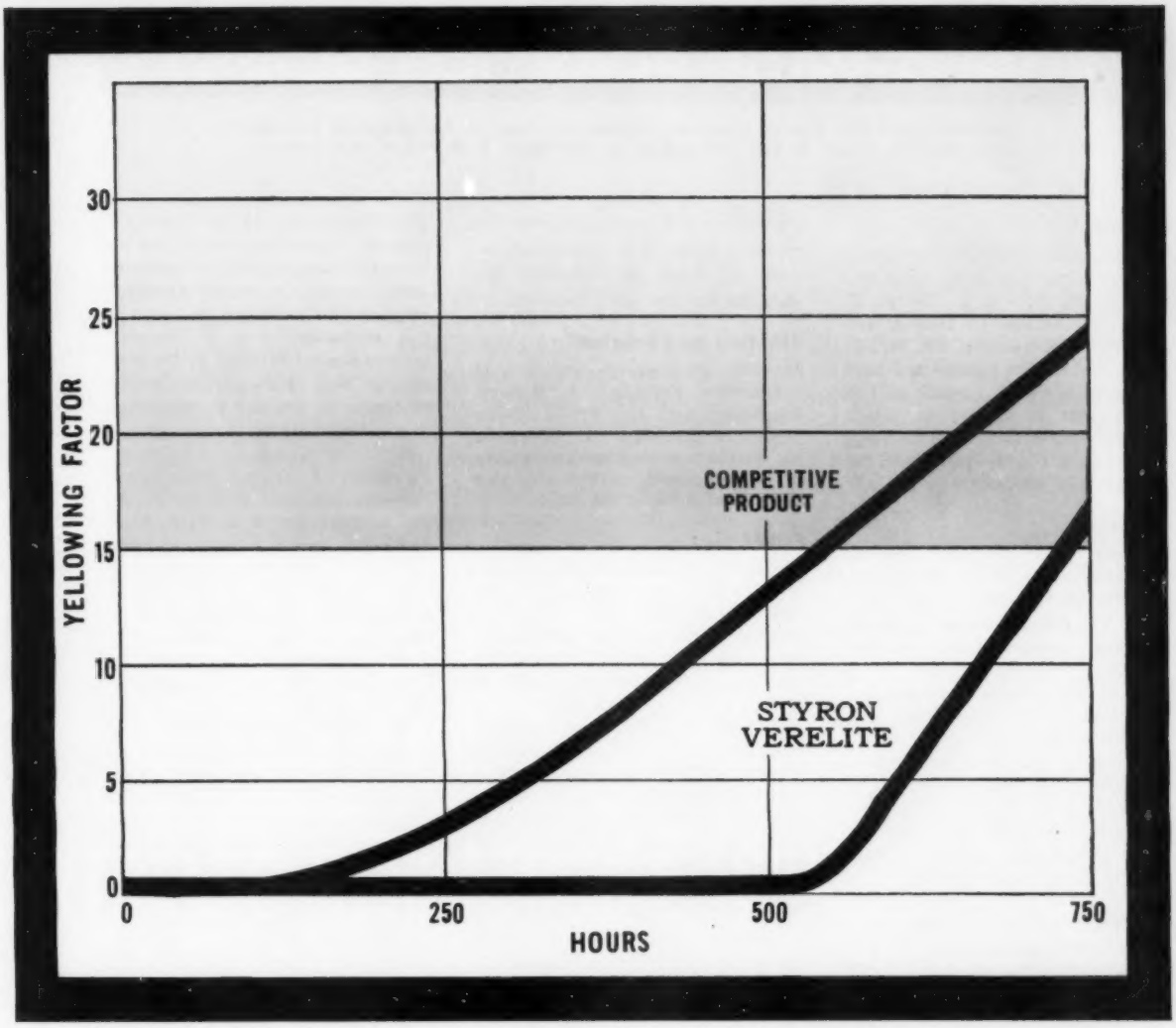
Cooling water baffle for molds

The Richards Type B-4 cooling baffle consists of a 2-in.-long casting with inlet and outlet ports for cooling water. Used with a 2-in.-long nipple and a 10-in. length of pipe (both supplied), it carries water to the bottom of a drilled hole in the mold block; the mold water is drained from the mold by passing countercurrent to the incoming water on the outside of the smaller 10-in.-diam. inlet pipe and thence out of the mold through the baffled casting. The unit is useful on molds which are found to have inadequate cooling and which permit the addition of the hole to accommodate the device. Complete baffle assemblies are available in single units at $3.75 ea.; baffle castings alone are available at $2.25 ea. in lots of six. *Richards Tool & Mold Co., Racine, Wis.*

Web guides

A change in the materials of construction has resulted in two lower-cost models of Mount Hope web-guiding devices used to keep webs centered on rolls in plastic processes. Model A has an aluminum frame, stainless steel accessory parts, and nip-roll de-nippers; it is suitable for wet and mildy acid service. Model B is also made of aluminum, but has parts made of cad- **(To page 159)**





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WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

Principles and methods of determining quality of molding compounds and moldings in France. R. Barrat, B. Bossu, Ph. Droux, P. Dubois, and R. Herou. Kunststoffe *51*, 422-27 (Aug. 1961). The process and legal aspects of a quality symbol used in France that is applied to plastic molding compounds and to moldings are described and compared with the German DIN symbol.

Materials

Polymers with inorganic primary molecular chains. K. A. Andrianov. J. Polymer Sci. *52*, 257-76 (July 1961). The preparation and properties of inorganic polymers are reviewed.

Hydrocarbon resins in paper coatings. P. O. Powers and J. F. Pflum. Ind. Eng. Chem. *53*, 371-74 (May 1961). New work on polydiene and polyterpene resins shows that they are largely hydrogenated cyclic compounds with no aromatic structure. These thermoplastic hydrocarbon resins are available in almost unlimited supply in many grades of varying physical properties including color, melting point, molecular weight, and film strength. As such, they constitute a readily available, inexpensive, chemically stable base for the formulation of wide varieties of hot-melt, solvent solution, emulsified, and powdered resin coatings. As additives to polyethylene and polypropylene, they reduce cost and improve coating features by giving reduced viscosity, lower moisture vapor transmission rates, better adhesion, and improved pigment wetting.

Applications

Improved closure of flexible barriers. H. W. Christie. Modern Packaging *34*, 213-17, 220-21 (Apr. 1961). Development of a rounded-jaw heat sealer has led to more efficient sealing of flexible packaging materials. Tensile strength of the heat seals was increased to 80% or more of the strength of the barrier material. The equipment is described, and data are given for the properties of both polyethylene and polyvinyl chloride materials laminated with aluminum foil and polyester film.

Initial success of plastic wires given impetus by new developments. H. Dyer. Paper Trade J. *145*, 30-32 (May 22, 1961). Plastic paper machine wires can now be run with less extensive Fourdrinier modification because of recent developments. The wire life has also been increased.

Molding and fabricating

Injection stamping—a procedure to compensate shrinkage. J. Wallner. Plastverarbeiter *12*, 229-32 (June 1961). A procedure to compensate for shrinkage in the injection molding of acrylic plastics utilizes core dies that are movable in the mold.

Properties

Thermal conductivity studies of polymers. D. E. Kline. J. Polymer Sci. *50*, 441-50 (Apr. 1961). A study of the thermal conductivity of some amorphous and partially crystalline polymers as a function of temperature (0 to 100° C.) is described. Experiments were made, with the use of a thermal conductivity cell with cylindrical geometry, on polyethylene, polytetrafluoroethylene, polystyrene, polyhexamethylene adipamide, and polymerized epoxy resin. The conductivity of amorphus polymers increases with temperature and is significantly higher in crystalline regions than in the amorphous regions. Data concerning the change of thermal conductivity of polymerized epoxy with the addition of powdered aluminum filler are given.

Thermal expansion of technical solids at low temperatures. R. J. Corruccini and John J. Gniewek. National Bureau of Standards Monograph *29*, 22 pp. (May 19, 1961). Tables are given of the linear contraction relative to 293° K., $(L_{293}-L_T)/L_{293}$, and the linear expansion coefficient, $dL/L_{293}dT$, of 30 elements, 45 alloys, 22 other inorganic substances, and 20 plastics and elastomers in the temperature range 0 to 300° K.

Influence of some selected fabrication variables on structural metal-to-metal bonding. G. Epstein and S. Litvak. Adhesives Age *4*, 36-39 (June 1961). The effects of surface treatments, primers, entrapped air, curing pressures, and curing temperatures on the strength of bonds made with epoxy adhesives and steel, titanium, beryllium, and nickel adherents are given.

Testing

Dynamical mechanical testing of polymers. G. C. Karas and B. Warburton. Brit. Plastics *34*, 131-7 (Mar. 1961). The fundamentals of non-destructive dynamic mechanical testing are reviewed. A method of test which overcomes certain limitations associated with solution techniques and destructive mechanical tests is described. Information on structure of the polymer, as well as its physical properties, may be obtained through study of viscoelastic methods.

Formation of carboxyl endgroups in polymers and their detection by the dye partition test. S. R. Palit, B. N. Mukherjee, and R. S. Konar. J. Polymer Sci. *50*, 45-52 (Mar. 1961). Carboxyl groups or end-groups were introduced into polymers by use of the following four general methods: 1) use of a carboxyl-bearing initiator, 2) copolymerization with a carboxyl-bearing monomer, 3) chain transfer with a molecule containing an actual or potential COOH group, and 4) transformation of a reactive group already present in the polymer. The presence of the carboxyl end-group in the polymer was tested by a new technique which is called the "dye partition test."

Determination of sulfate ash and lead content of lead-stabilized PVC. W. Meyer. Kunststoffe *51*, 312-314 (June 1961). Vinyl chloride plastics are decomposed with a mixture of concentrated sulfuric and nitric acids and any lead that is present is determined as lead chromate.

Dye tests pinpoint groups on polymers. Chem. Eng. News *39*, 40-41 (Aug. 7, 1961). A dye partition and a dye interaction test are used to detect certain groups such as carboxyl, bisulfate, hydroxyl, amines, and halides in polymers.

Publishers' addresses

Adhesives Age: Palmerton Publishing Co. Inc., 101 W. 31st St., New York 1, N. Y.

British Plastics: Iliffe & Sons Ltd., Dorset House, Stamford St., London SE1, England.

Chemical and Engineering News: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Der Plastverarbeiter: Morschgasse 33-35, Speyer/Rhein, Germany.

Industrial and Engineering Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Journal of Polymer Science: Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y.

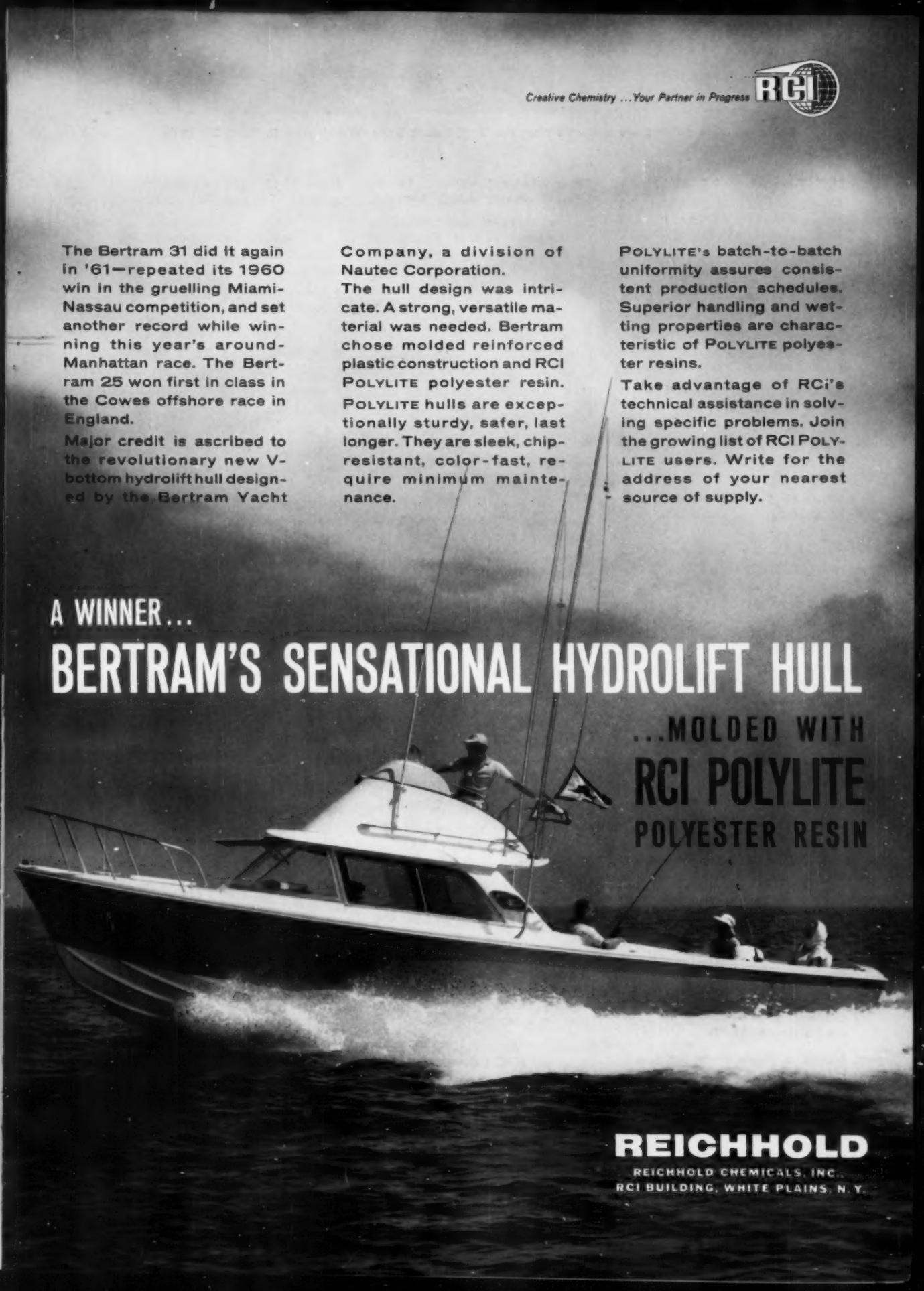
Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.

Modern Packaging: Modern Packaging Corp., 770 Lexington Ave., New York 21, N. Y.

National Bureau of Standards Monograph: Connecticut Ave., Washington 25, D. C.

Paper Trade Journal: Lockwood Trade Journal Co. Inc., 15 W. 17th St., New York 36, N. Y.—End

*Reg. U.S. Pat. Off.


Creative Chemistry ...Your Partner in Progress
RCI
The Bertram 31 did it again in '61—repeated its 1960 win in the gruelling Miami-Nassau competition, and set another record while winning this year's around-Manhattan race. The Bertram 25 won first in class in the Cowes offshore race in England.
Major credit is ascribed to the revolutionary new V-bottom hydrolift hull designed by the Bertram Yacht Company, a division of Nautec Corporation.
The hull design was intricate. A strong, versatile material was needed. Bertram chose molded reinforced plastic construction and RCI POLYLITE polyester resin.
POLYLITE hulls are exceptionally sturdy, safer, last longer. They are sleek, chip-resistant, color-fast, require minimum maintenance.
POLYLITE's batch-to-batch uniformity assures consistent production schedules. Superior handling and wetting properties are characteristic of POLYLITE polyester resins.
Take advantage of RCI's technical assistance in solving specific problems. Join the growing list of RCI POLYLITE users. Write for the address of your nearest source of supply.
A WINNER...
BERTRAM'S SENSATIONAL HYDROLIFT HULL
...MOLDED WITH
RCI POLYLITE
POLYESTER RESIN
REICHHOLD
REICHHOLD CHEMICALS, INC.
RCI BUILDING, WHITE PLAINS, N.Y.

U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U. S. Pats., Aug. 15, 1961

Halogenated ethylene copolymers. W. P. Cain, L. S. Minchler Jr., and H. S. Makowski (to Esso). 2,996,473.

Cross-linked polymers. P. W. Juneau Jr. (to General Electric). 2,996,476.

Polyester composition. S. H. Long, C. E. Tholstrup, and M. T. Watson (to Eastman Kodak). 2,996,477.

Polyvinyl fluoride resins. H. B. West (to Du Pont). 2,996,478.

Methacrolein copolymers. R. L. Eifert and B. M. Marks (to Du Pont). 2,996,481.

Polypiperazine adipamides. R. E. Albert and W. G. Vosburgh (to Du Pont). 2,996,482.

Binary vinyl chloride copolymers. R. H. Martin Jr. (to Monsanto). 2,996,484.

Chlorination of coumarone-indene resins. J. R. Patterson, W. H. Williams, and J. J. Freeman (to Neville). 2,996,485.

Fluorobutadiene copolymers. A. N. Bolstad and J. M. Hoyt (to 3M). 2,996,487.

Polypropylene. J. L. Jezl, H. M. Khelghatian, and L. D. Hague (to Sun Oil). 2,996,491.

U. S. Pats., Aug. 22, 1961

Embossed plastics. D. W. Sonza (to Dymo). 2,996,822.

Irradiated polyethylene. R. D. Lowry and J. W. Harrison (to W. R. Grace). 2,997,170.

Polyvinyl chloride propellant. K. E. Rumbel and M. Cohen (to Atlantic Research). 2,997,375.

Photosensitive polyamide resins. M. H. Murray and R. M. Leekley (to Time). 2,997,391.

Precision molds. H. Greenewald Jr., 2,997,400.

Cold-welding polyesters. E. J. Lawton (to General Electric). 2,997,419.

Molded fluorocarbon polymer. J. Hochberg (to Du Pont). 2,997,448.

Polyacrylonitrile compositions. A. Armen, F. A. Ehlers, and S. A. Murdock (to Dow). 2,997,451.

Sulfone - containing polysiloxanes. S. W. Kantor (to General Electric). 2,997,457.

Epoxy-substituted silicones. D. W. Lewis (to Westinghouse). 2,997,458.

Polycarbonates. H. Schell, W. Kimpel, L. Bottenbruch, H. Krimm, and G. Fritz (to Bayer). 2,997,459.

Amine-modified phenolic resins. M. DeGroote (to Petrolite). 2,997,460-1.

Surface-active polyesters. C. Wulff, M. Dohr, and H. J. Krause (to Henkel). 2,997,462.

U. S. Pats., Aug. 29, 1961

Crystalline polystyrene. R. A. Isaksen, M. Ezrin, S. Newman, and R. Buchdahl (to Monsanto). 2,997,743.

Phosphenitrilic chloride polymer. L. V. Gregor and J. A. Parkins (to Du Pont). 2,998,297.

Resinous polyhydric phenol. S. O. Greenlee. 2,998,398.

Polyisocyanate-polyester. J. C. Petropoulos (to American Cyanamid). 2,998,399.

Polyurethane. E. Muller, O. Bayer, and H. Morschel (to Bayer & Mobay). 2,998,403.

Polymethylene terephthalate. G. J. Zoetbrood (to Research). 2,998,408.

Polyoxymethylene carboxylates. S. D. Nogare and J. O. Punderson (to Du Pont). 2,998,409.

Methylolmelamines. A. W. Jeffs, R. N. Housekeeper, and W. J. Quinlan (to American Cyanamid). 2,998,410-1.

Polyurethanes. H. Holtschmidt, G. Nischk, and W. Kallert (to Bayer & Mobay). 2,998,413.

Polyesters. W. W. West and P. K. Mulvaney (to California Research). 2,998,414.

Unsaturated ether resins. E. M. Geiser (to Universal Oil). 2,998,415.

Spirobi (meta-dioxane) sulfide polymers. H. A. Stansbury and H. R. Gunst (to Union Carbide). 2,998,427.

Diacetylene copolymers. L. S. Meriwether and E. C. Colthup (to American Cyanamid). 2,998,463.

Foamed structures. E. A. Edberg and R. H. Immel (to Koppers). 2,998,501.

U. S. Pats., Sept. 5, 1961

Rocket warhead. W. E. Land. 2,998,772.

Irradiation bonding to shaped structures. D. Tanner (to Du Pont). 2,999,056.

Highly crystalline polyethylene. E. V. Fasce, N. L. Cull, and R. J. Fritz (to Esso). 2,999,086.

Polymerization of piperylene. R. M. Thomas and C. W. Seelbach (to Esso). 2,999,087.

U. S. Pats., Sept. 12, 1961

Polyoxylylenes. T. E. Young (to Du Pont). 2,999,820.

Anion-exchange resins. S. A. Fisher (to Rohm & Haas). 2,999,821.

Copolymers. E. S. Pfau, G. H. Swart, and K. V. Weinstock (to General Tire). 2,999,822.

Foamed plastics. B. A. Dombrow (to Nopco). 2,999,823.

Polyepoxides. F. G. Singleton and W. C. Hunt (to H. H. Robertson). 2,999,824.

Epoxy-polyamide ester resin. D. E. Floyd and D. E. Peerman (to Gen. Mills). 2,999,825-6.

Polymethacrolein. E. E. Gruber and E. F. Kalafus (to General Tire). 2,999,830.

Polysiloxanes. E. P. Goldberg (to General Electric). 2,999,835.

Epoxy composition. R. E. Ludwig (to Du Pont). 2,999,836.

Inhibiting mold corrosion. B. Franzus (to Phillips). 2,999,837.

Shaped polymers. J. M. Quinn and A. K. Schneider (to Du Pont). 2,999,838.

Polycarbonates. E. Muller and O. Bayer (to Bayer and Mobay). 2,999,844.

Polycarbonate-siloxane composition. E. P. Goldberg (to General Electric). 2,999,845.

Polycarbonates. H. Schnell and H. Krimm. 2,999,846.

Urea resins. J. J. Nemes and R. D. Vartanian (to American Cyanamid). 2,999,847.

Sulfone polyesters. D. M. Young and C. F. Horn (to Union Carbide). 2,999,848-9-50.

Isocyanate-polyesters. O. C. Elmer (to General Tire). 2,999,851.—**End**

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Now all vinyls—*even rigids*—can be made non-toxic with one of the 3 new F&DA approved Argus stabilizers: Mark 33, 34, and 35.

Each, used in its specific applications, gives stability superior to that of any non-toxic stabilizer available. All 3 withstand the extremely high heat needed to process rigids. And are finding wide application in calendered, extruded and molded vinyls for the food, drug and baby product fields.

Toxicity is only one of dozens of technical problems put to Argus each week. Flexibility at low temperatures, plastisol bubble break, and better stabilization of electrical compounds and of clear rigids are other frequent posers. Argus finds the answers. Either in existing Mark stabilizers and Drapex plasticizers, or through research in our lab.

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European Affiliates: SA Argus Chemical NV; 33, Rue d'Anderlecht, Drogenbos, Belgium—Lankro Chemicals, Ltd.; Salters Lane, Eccles, Manchester, England.

LETTERS TO MODERN PLASTICS

Error on press

Sir: We were especially interested in seeing your report on the Interplas Exhibition in the Supplement to your July issue, however, for the record, we feel we should point out a small error relating to the Daniels 250-ton press mentioned in your report. It is stated that platens up to 12 ft. long and 5 ft. wide were in use on this machine, whereas the machine accommodates platens up to 8 ft. long and 4 ft. wide.

We only mention this point because we would not like our customers to be misled otherwise.

W. D. Pereira
Publicity Officer
T. H. & J. Daniels Ltd.
Stroud, Glos., England

Where credit is due

Sir: Concerning the article, "Beverage cases: coming market for high-density polyethylene," which began on p. 88 of your August issue, we would like to correct some credits that were printed.

The mold for our beer cases was designed by A. J. Simons of Polk, Pa., and built by Shaw Industries Inc., Franklin, Pa. Your article credits Akromold Inc. with building the die. We believe that both the die designer and Shaw Industries should receive credit which is due them.

The idea for a plastic beer case was originated by our president, John A. Friday Jr.

William H. McCullough
Dir. of Engr.
Duquesne Brewing Co.
Pittsburgh, Pa.

Suggested abbreviation

Sir: Is there any standard abbreviation for polyethylene terephthalate? If not, perhaps PETP might be adopted by your magazine and by others in the plastic industry. I bring this up because we and a number of other companies have been using the term polyester film to describe the material sold by Du Pont under the tradename Mylar. Now that another brand of polyester film of different chemical composition and claimed superior electrical properties is now being made in pilot quantities, it becomes most important for both the film manufacturers and film users (both equipment manufacturers and equipment purchasers) to be able to distinguish between the two films.

Du Pont, in a similar case, has distinguished between its Teflon fluorocarbon films by describing them as FEP and TFE fluorocarbon films.

Sidney L. Chertok, Mgr.
Adv. and Sales Promotion
Sprague Electric Co.
North Adams, Mass.

There is no standard abbreviation at present. We have long advocated the need for an alphabetical nomenclature for plastics materials to simplify the plethora of industry tradenames. For example, refer to our editorial, "Let's stop this tradename nonsense" in our October issue. If such an accepted list is ever adopted, your suggestion is indeed a logical one.—Ed.

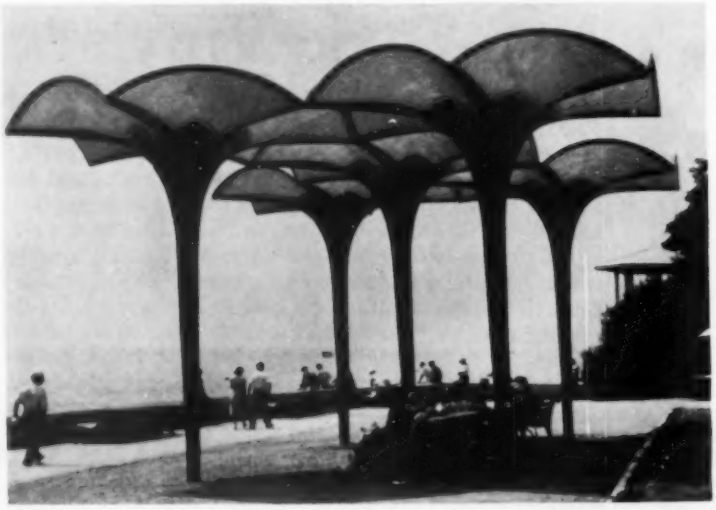
Purloined pavilion

Sir: Remember at the time of the U. S. Exhibition in Moscow in 1959, you carried a cover story (Dec. 1959) about the plastics pavilions which were erected there? After the show was over, we were never quite sure what happened to the 90 individual umbrellas. Recently, a photograph was received from Russia showing five of these translucent columns erected at the Park of Rest and Culture in Yalta. As you can see from the photo below, the umbrellas are still apparently in good shape, although a highly chlorinated polyester was deliberately selected—for maximum fire resistance—even though such resins were not supposed to be particularly weather resistant. We had been told clearly that the pavilions were to be temporary structures, and were to be discarded after the show was over.

It might be noted that the original design was based on clusters of not less than 16 units to develop sufficient combined action to resist winds of 60 m.p.h. We do not know how the small cluster of five would stand in a high wind. Also, of course, they were not designed to carry snow loads, but we understand that, in the Crimea, heavy snow loads are not expected.

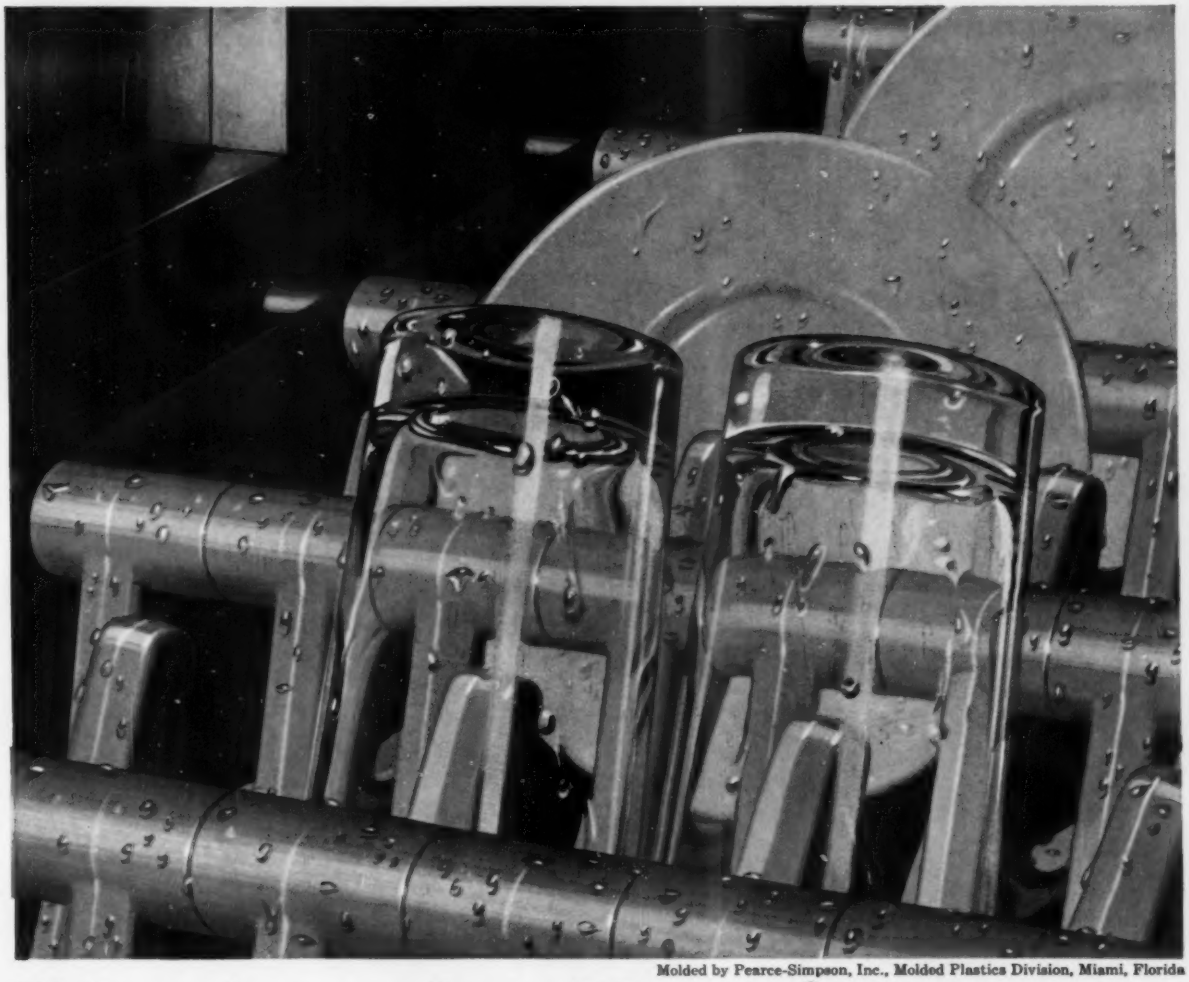
Albert G. H. Dietz
Prof. of Building Engineering
Massachusetts Institute of Technology
Cambridge, Mass.

Prof. Dietz acted as the engineering consultant for the United States pavilion at the Moscow show.—Ed.



U.S.-MADE RP UMBRELLAS, once part of Moscow exhibit, now shield Russian vacationists from sun at Black Sea resort.

What's News in Plastics...



Molded by Pearce-Simpson, Inc., Molded Plastics Division, Miami, Florida

Dishwasher cradles of Escon® polypropylene defy high heat and detergents

The Jackson Products Company of Tampa, Florida, chose Escon polypropylene for the conveyor-belt cradles on its new flight-type dishwasher. Resistance to high heat and detergents was the overriding reason. Of all materials considered (including metals and other plastics), Escon best withstood the punishing chemical attack of wetting agents found in commercial dishwashing compounds.

The resilience of Escon creates a cushioning effect which minimizes breakage, while its negligible water absorption contributes to long life. And with Escon, cradles can be made in a variety of contrasting colors.

Properties like these point to Escon polypropylene as the ideal choice for many demanding applications. To find out more about this versatile material, write to Enjay, 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

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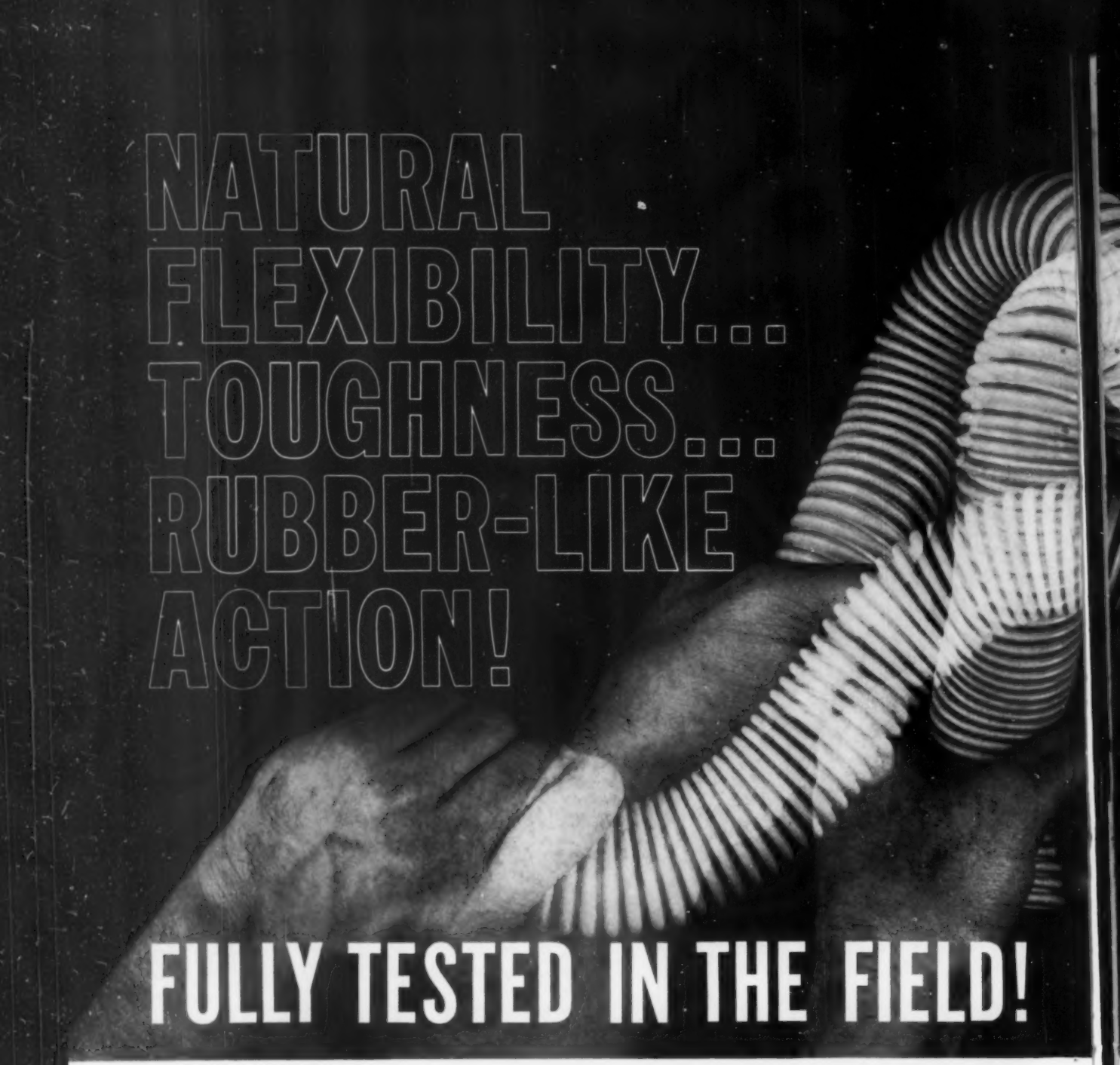
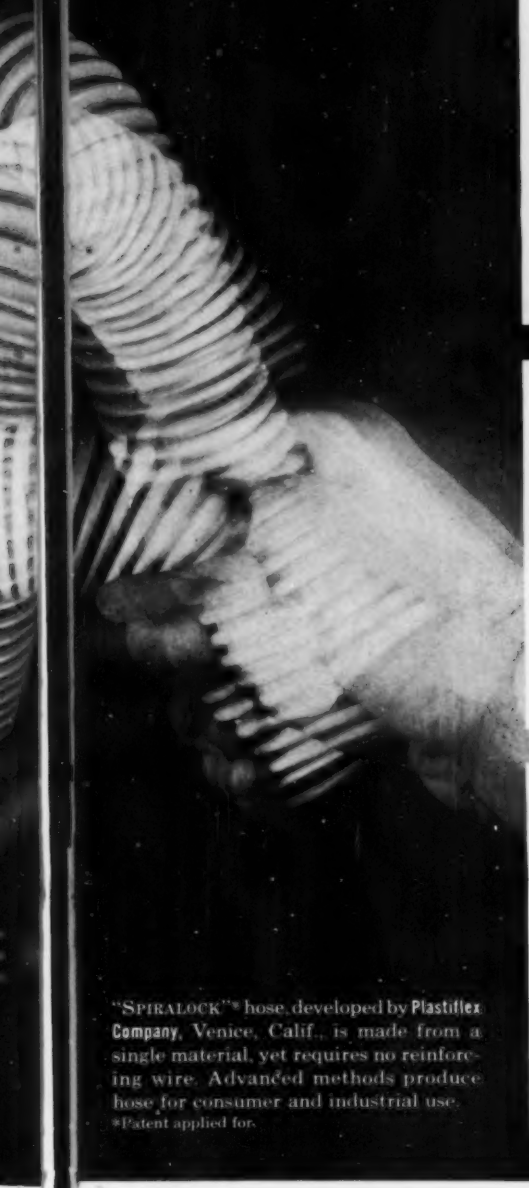


BAKELITE DPD-6169 Ethylene Copolymer gives you all 3...without a plasticizer! Easy to fabricate! Good stress-cracking resistance and low temperature properties, too!

Touch it! DPD-6169 has a rubbery "feel" and texture.

Bend it! In flex-cracking tests, using Ross Rubber Test Apparatus, DPD-6169 survived more than 2,000,000 cycles at room temperature. Other flexible plastics fail anywhere from 10,000 to 135,000 cycles.



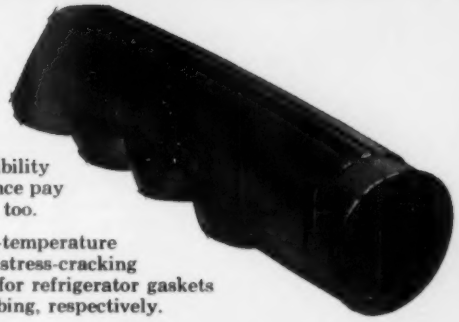
"SPIRALOCK"* hose, developed by **Plastiflex Company**, Venice, Calif., is made from a single material, yet requires no reinforcing wire. Advanced methods produce hose for consumer and industrial use.
*Patent applied for.

PACKAGING: Excellent flex life makes DPD-6169 ideal for unusual squeeze and bellows-type dispensers, spray bottles for insecticide, etc.

AUTOMOTIVE: No plasticizer "fogging" because there's no plasticizer!

HOUSEWARES: A likely successor to rubber because of its excellent aging resistance, flexibility, easy colorability. Ideal for mats and trays.

FURNITURE: No lacquer marring due to plasticizer migration. Higher coefficient of friction makes it ideal for non-slipping caster cups.



TOYS: (right) When toys must withstand severe punishment, DPD-6169's extreme flexibility and flex-cracking resistance pay off. Competitive in price, too.

APPLIANCES: (left) Its low-temperature properties and excellent stress-cracking resistance make it ideal for refrigerator gaskets and washing machine tubing, respectively.

Excellent low-temperature performance—Maintains flexibility at temperatures colder than −105°C. Materials which require added plasticizers simply cannot do this.

Natural flexibility! DPD-6169 comes by its high flexibility naturally—no plasticizer is needed. That means freedom from embrittlement, and other problems due to migration.

Fully field-tested! BAKELITE DPD-6169 is receiving an enthusiastic welcome from hundreds of fabricators. Many of them already consider DPD-6169 a major contribution to the plastics industry.

Competitively priced! DPD-6169's low pound volume cost makes it competitive with other materials!

Easy to mold and extrude—Field trials and production experience have proved out the excellent flow characteristics and processing latitude of DPD-6169.

For complete information on BAKELITE DPD-6169 Ethylene Copolymer, write Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

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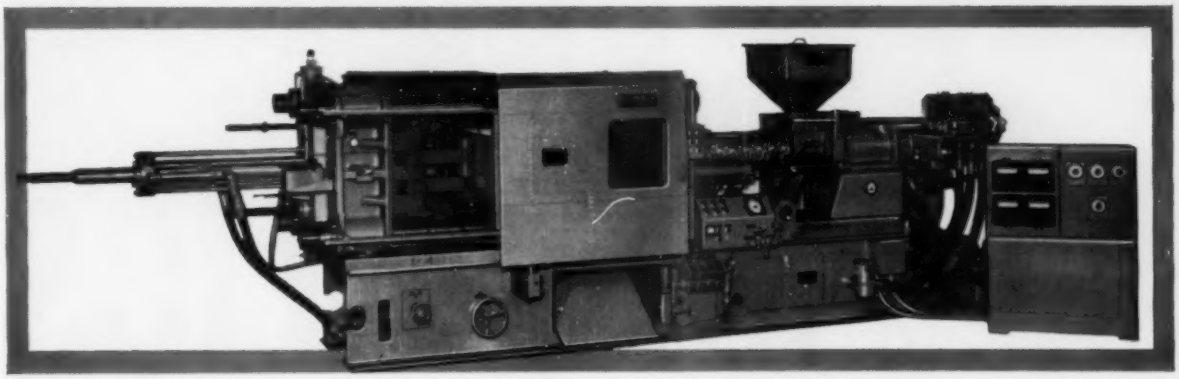

Condensed Screw Specifications				
	275TC	**350TC**	**350TCL**	**450TC**
Material injected per shot (cu. in.)	57.5	57.5	57.5	57.5
Material plasticizing capacity (lbs./hr.)	200	200	200	200
Material displacement rate (cu. in./min.)	1138 (30HP)	1510 (40HP)	1510 (40HP)	1771 (50HP)
	1150 (40HP)	1770 (50HP)	1770 (50HP)	
Screw diameter (in.)	3⅞	3⅞	3⅞	3⅞
Plunger speed forward (in.)	130 (30HP)	172.5 (40HP)	172.5 (40HP)	220 (50HP)
	172.5 (40HP)	220 (50HP)	220 (50HP)	
Mold clamping pressure (tons)	275	356	372	480
Mold clamping stroke, in. (adjustable)	6¼—11½	7½—14½	8½—20¼	6—22⅝
Platen size, in. (H x V)	27x27¼	32½x32½	32½x32½	40x40
Space between tie bars (H x V)	16½x16½	20½x20½	20½x20½	26x26
Motor HP	Std.—30	Std.—40	Std.—40	50
	Optn'l-40	Optn'l-50	Optn'l-50	

Exclusive screw design, different from any other available today, is part of REED "Building Block" line

This new unit, a single reciprocating screw that plasticizes and injects all thermoplastic materials, has no thrust bearing to maintain. Its one-piece construction keeps problems of alignment, squareness and parallelism to a minimum. A fingertip-operated valve controls back pressure on the screw, helps give uniform high product quality.

You can specify this screw (capacity up to 32 oz.) as an integral part of the 20 different combinations available in the REED "Building Block" injection group. With it, you may expect good color blending on dry mix, good material and color changes. You get better homogeneity of the melt, maintain more effective injection pressures. Because there is less orientation of the plasticized material, finished parts are stronger.

Ask your Reed-Prentice Sales Engineer for full details on the "Building Block" line . . . find out how you can now specify the machine that meets your *exact* needs.

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THREE NEW PHENOLICS FROM GENERAL ELECTRIC

G-E 12985 **This new General Electric compound is the very finest *heat-resistant* phenolic available in its cost range.**

12985 retains high flex strength after severe heat aging. It has a rich, black color which it maintains well on exposure to heat. The material has a drop impact strength higher than its best competitor . . . equivalent *for the first time* to a general-purpose compound. 12985 takes a hot, speedy preheat and cures rapidly. It has excellent machining properties, good chemical resistance, relatively low specific gravity (1.58). And—it is offered at an attractive price.

SUGGESTED USES: This superb high-temperature material is particularly recommended for handles on skillets and cutlery, for appliance parts, switch and lamp parts, knobs, wiring devices, miniature parts for use at high ambient temperatures.

G-E 12941 **A new concept in general-purpose phenolics: a fast-curing, ammonia-free, non-bleeding black compound.**

This material gives an extremely fast, blister-free, cold-powder cure. There is no danger of staining the mold or tarnishing costly silver contacts. Nor is there any need to worry about high scrap losses caused by uneven flow. Parts produced from 12941 will not bleed.

SUGGESTED USES: Ideal for small, automatically molded parts of all kinds: switch parts, contacts for wire connectors, closures, tube sockets, appliance control parts.

G-E 12942 **This new variant of a popular general-purpose compound offers added impact strength, improved finish and cure.**

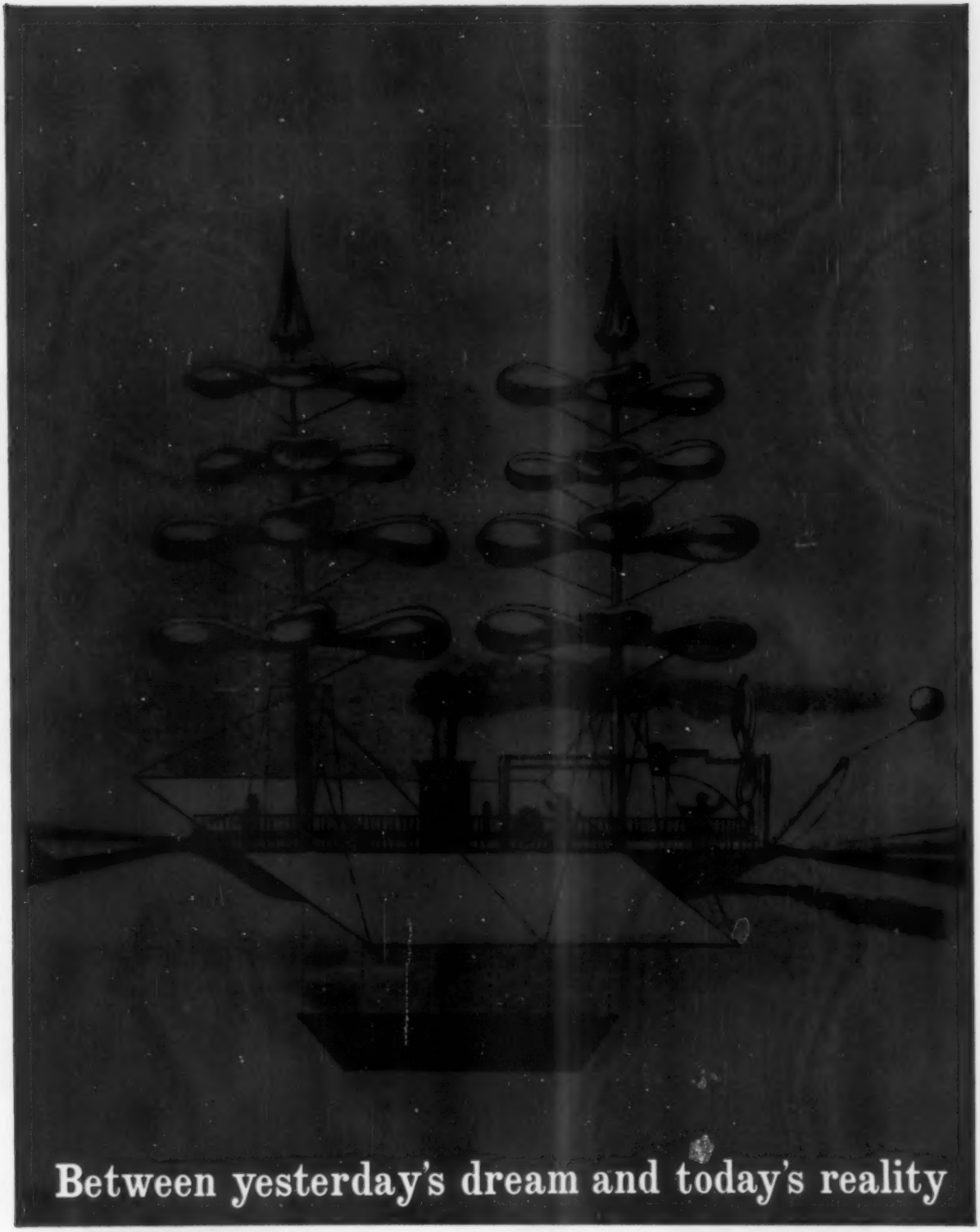
A versatile and easily molded compound, 12942 pre-forms well, takes a hot preheat, and flows smoothly in the mold. Parts made of the new compound are smooth, rigid, deep-black, and will not embrittle during tumble finishing. It can be used in cold powder automatic molding with just a slight penalty in cure speed. It is not hand staining.

SUGGESTED USES: General applications such as handles, knobs, meter case covers, coffee maker bases, piano sharps.

These three new compounds may well give you an important advantage in processing or properties. General Electric offers you dozens of standardized phenolic compounds, including general purpose, heat resistant, shock resistant, and fast cure phenolics. Our Technical Service people will be glad to help you select the right material for your job. For more information, write to: General Electric Company, Section MP-661, Chemical Materials Department, Pittsfield, Mass.

Phenolics-first of the modern plastics...first in value

GENERAL ELECTRIC



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Research and Development: Cedar Grove, N.J., Greensboro, N.C., High Point, N.C. **Weaving:** Cheraw, S.C., Altavista, Va., Philadelphia, Pa., High Point, N.C. **Finishing:** Cheraw, S.C., Altavista, Va., Philadelphia, Pa., Cedar Grove, N.J.

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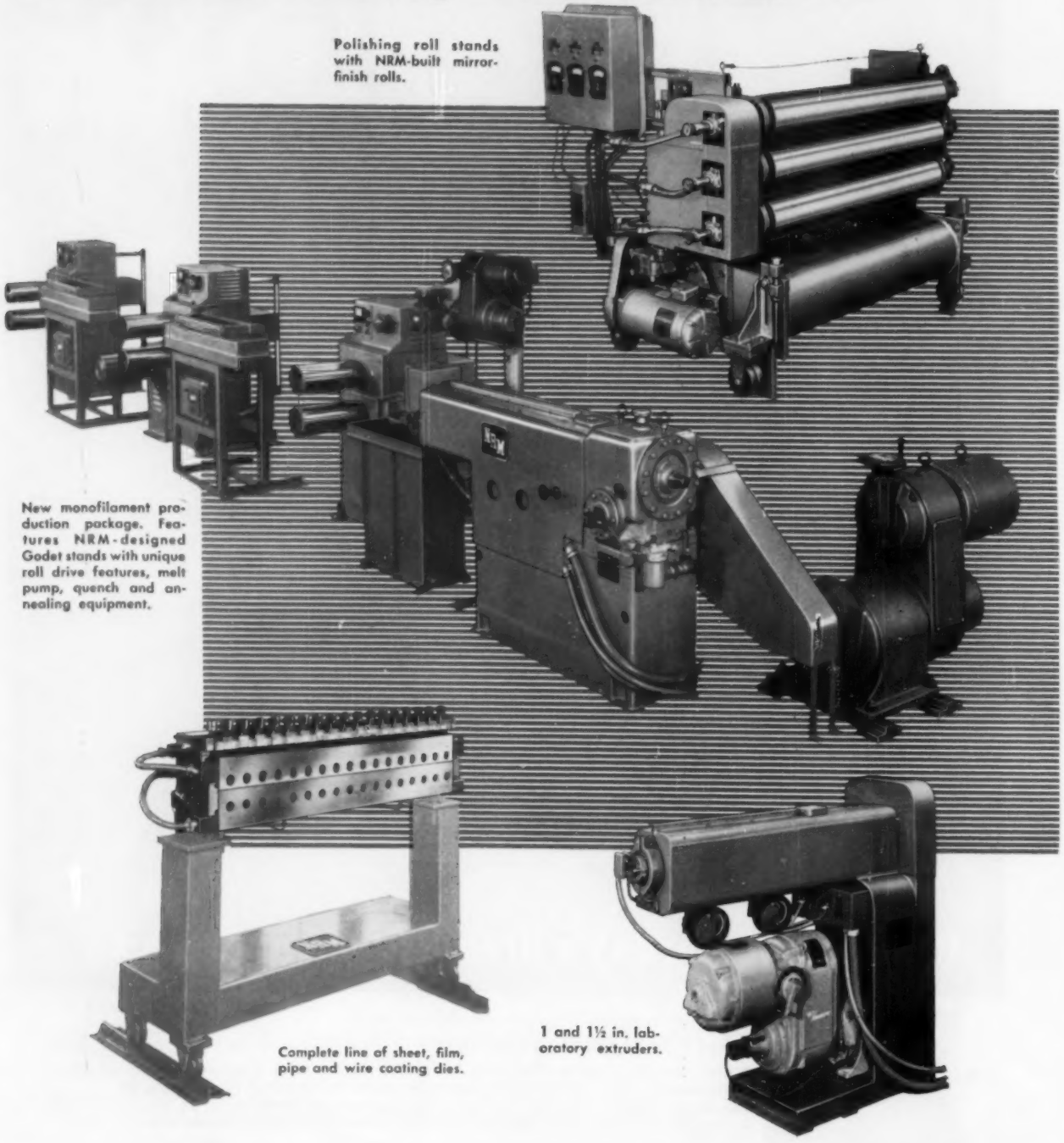

Polishing roll stands with NRM-built mirror-finish rolls.

New monofilament production package. Features NRM-designed Godet stands with unique roll drive features, melt pump, quench and annealing equipment.

Complete line of sheet, film, pipe and wire coating dies.

1 and 1½ in. laboratory extruders.

As the only manufacturer of standard thermoplastic extruders, in sizes from 1 through 15 in., NRM can recommend extrusion equipment *exactly* matched to your present and future needs.

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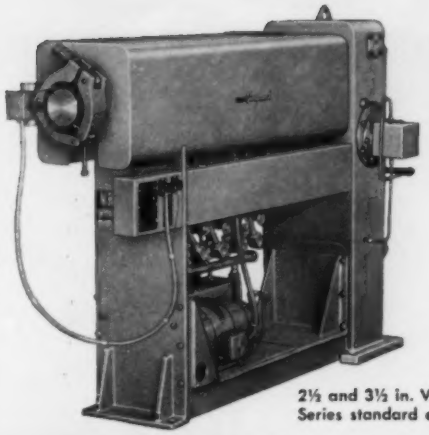
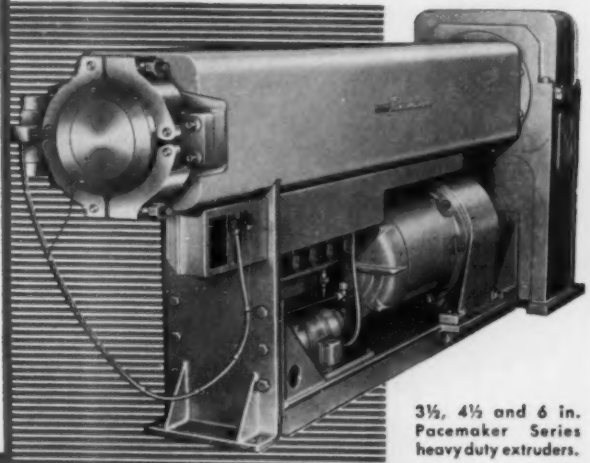
And, NRM'S years of experience in the development and manufacture of the finest plastics production machinery available today are at your service. Whether you're concerned with productivity, product quality, cost reduction, or a new process, you'll be money ahead if you call in NRM for recommendations while your project is in the planning stage. Call, wire or write today.



2½ and 3½ in. Vanguard Series standard extruders.



3½, 4½ and 6 in. Pacemaker Series heavy duty extruders.

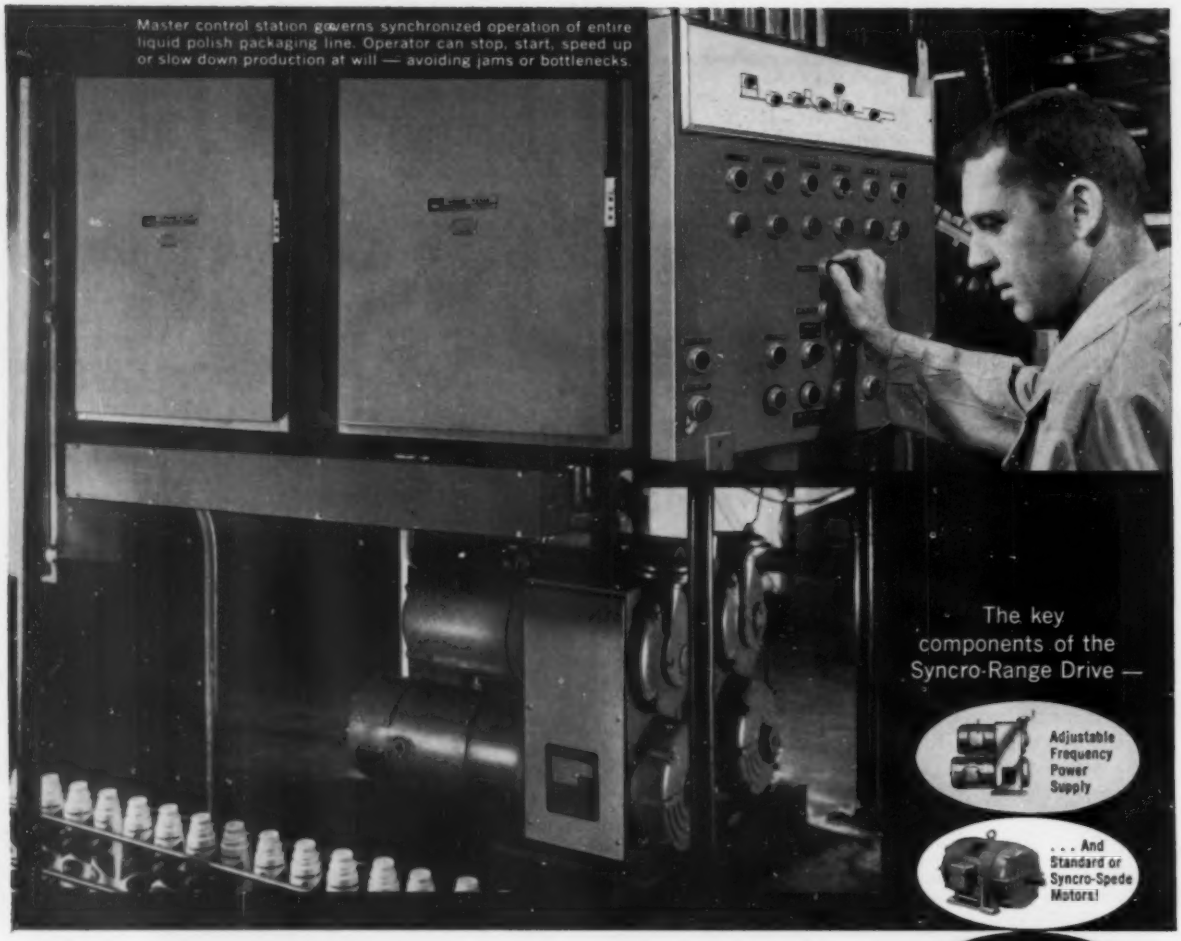
2223-A

8, 10, 12, and 15 in. high-capacity extruders.

NRM

NATIONAL RUBBER MACHINERY COMPANY

General Offices: 47 W. Exchange St., Akron 8, Ohio • **Eastern:** P.O. Box 432, Saddle Brook, N.J. • **Midwest:** 5875 No. Lincoln Ave., Chicago 45, Ill. • **Southeast:** J. D. Robertson, Inc., 3110 Maple Drive, N.E., Atlanta 5, Ga. • **West:** H. E. Buecken Co., P.O. Box 65, Pico Rivera, Cal. • **Canada:** Barnett J. Danson & Assoc., Ltd., 33 Railside Rd., Don Mills, Ontario • **Export:** Omni Products Corp., 460 Park Ave., S., New York 16, N.Y.


Master control station governs synchronized operation of entire liquid polish packaging line. Operator can stop, start, speed up or slow down production at will — avoiding jams or bottlenecks.
The key components of the Syncro-Range Drive —
Adjustable Frequency Power Supply
. . . And Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling the speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax.

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drive provides synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable frequency power supply operating on 3 phase, 60 cycle power input . . . a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load . . . and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and other similar machines which require the application of power at a number of points on the machine.

The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 motors. Control features are available to provide speed regulation accurate to 0.1% with 0% relative speed difference between motors! A trained Louis Allis motor application engineer is available to help. You can reach him at your local Louis Allis District Office, or by writing to The Louis Allis Company, East Stewart Street, Milwaukee 1, Wisconsin.

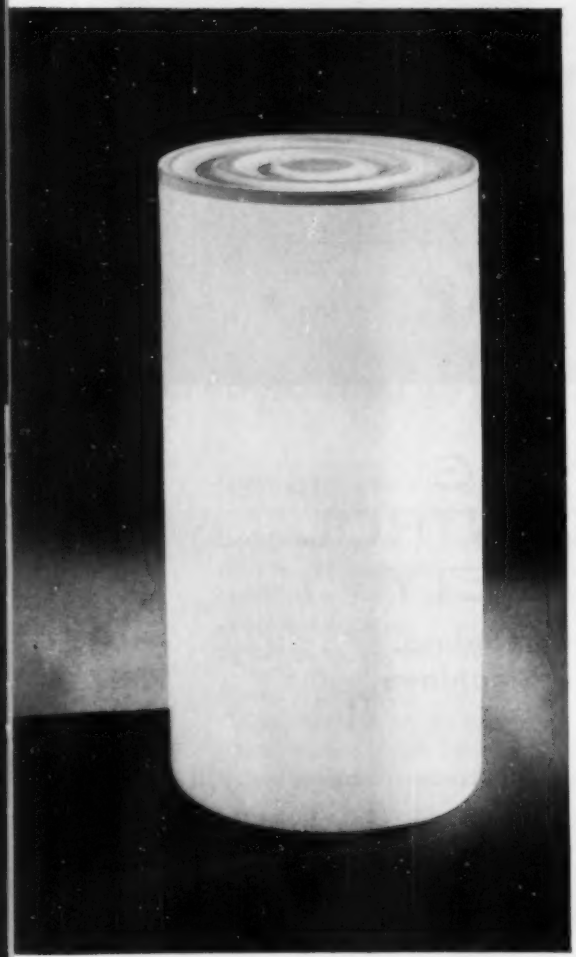
ASD-232

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

INSTRUMENT HOUSING—Made of MARLEX, it's lighter and more durable, resists cracking and warping . . . for "Plug-Scope," spark plug tester manufactured for Champion Spark Plug Company by Heyer Industries, Incorporated. Molded by Fibro Corp., Clark, N. J.

VAPORIZER HOUSING—Attractively styled for a popular Hankscraft product, this component has molded-in color and texture . . . won't warp or crack with boiling temperatures. Molded by Milwaukee Plastics, Milwaukee, Wis.



BRINE TANK—Welded of MARLEX sheet with Thermoformed top and bottom . . . this Premier Plastics water softener tank will never corrode or scale up . . . gives longer and improved service at low cost.

MARLEX* components for economical "quality up-grading"

To improve product performance while keeping production costs down, more and more manufacturers rely on components molded or formed from MARLEX high density plastics. A representative selection is shown here.

MARLEX plastics (high density polyethylenes and ethylene copolymers) are lightweight, tough, and virtually indestructible . . . resistant to acids, alkalies, greases, fungi, and corrosion. They possess high dielectric strength and a wide usable temperature range (−180°F to 250°F). Components of MARLEX can be molded, thermoformed, extruded, welded, machined, printed upon, and endowed with integral color.

*MARLEX is a trademark for Phillips family of olefin polymers.

RUG WASHER HOUSING—Precisely molded, this rugged Electrolux part of MARLEX is lightweight, tough, and non-corroding . . . will not chip, dent, bend or warp.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma, a subsidiary of Phillips Petroleum Company

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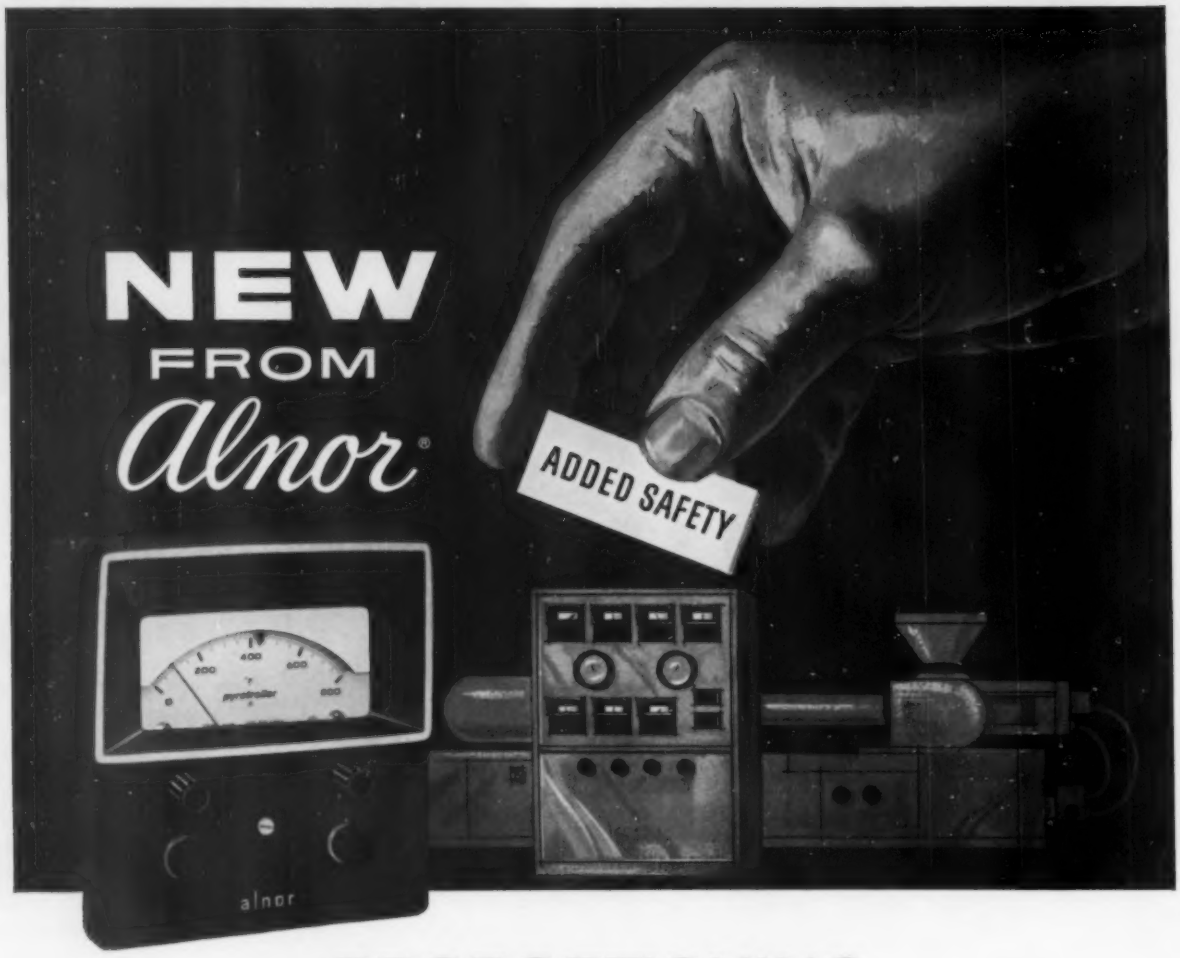
EXPORT: PHILLIPS PETROLEUM INTERNATIONAL CORPORATION • P. O. Box 7239, Panama City, Panama • Sumatrastrasse 27, Zurich 6, Switzerland

PHILLIPS 66 MARLEX PLASTICS



PROPORTIONING TEMPERATURE CONTROL with ADDED SAFETY

For Injection Molding, Blow Molding, Extruders and Heat Sealing Machines

HERE'S WHAT IT DOES—

1. Prevents starting of machine before plastic reaches correct molding temperature.
2. Will automatically shut-down machine if any heating element fails and the plastic drops below molding temperature.
3. The Alnor time proportioning control system accurately proportions the heat supply, thus maintaining the optimum temperature at all times.
4. Plug-in terminal features available.
5. The extremely rugged construction of the Alnor Controller makes it highly resistant to machine vibration and puts it in a class by itself for reliability.

PYROCON

Alnor—leader in temperature indicating instruments since 1919.

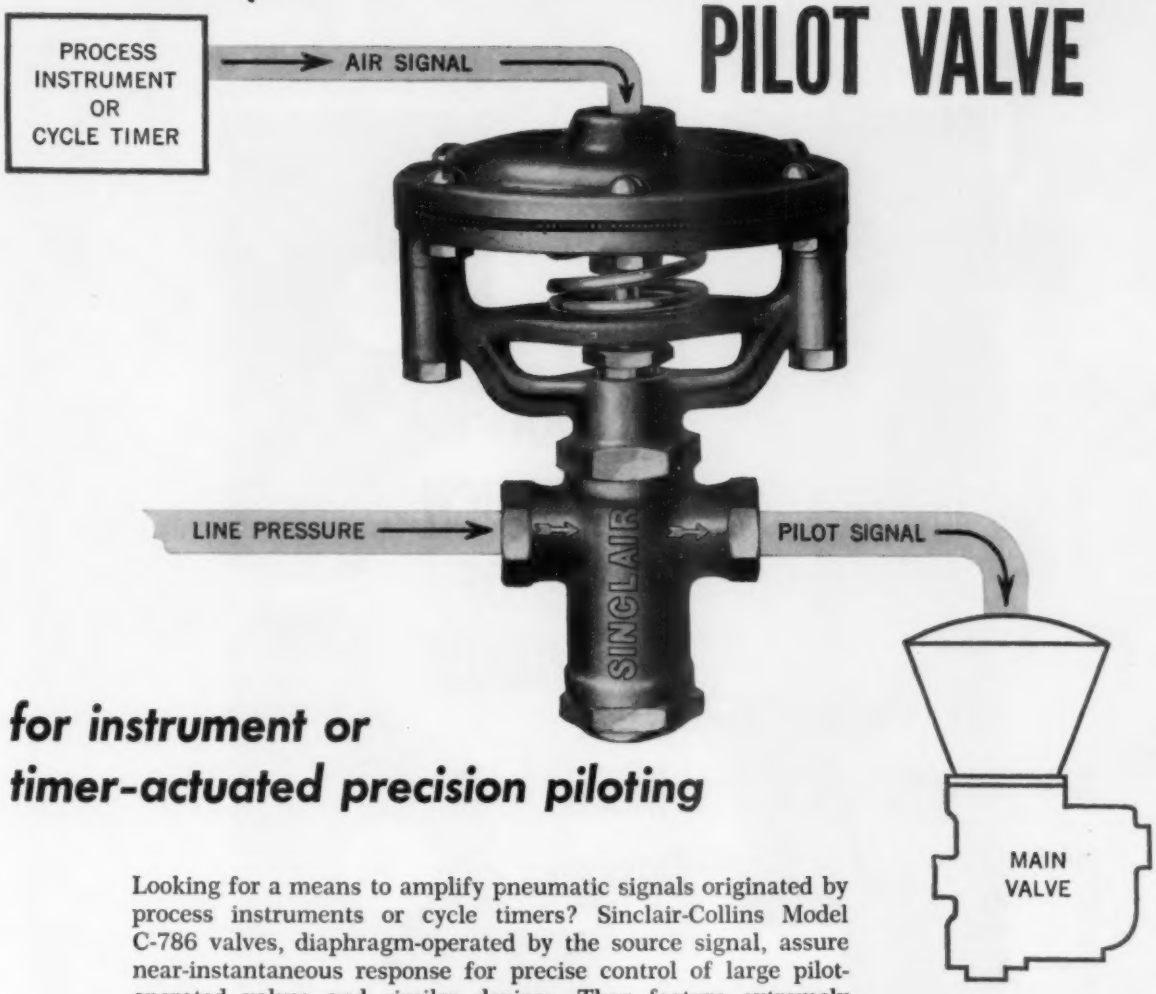
Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.

Division of Illinois Testing Laboratories, Inc.

Room 526 • 420 North La Salle Street • Chicago 10, Illinois

Compact, low-cost SINCLAIR-COLLINS PILOT VALVE



for instrument or timer-actuated precision piloting

Looking for a means to amplify pneumatic signals originated by process instruments or cycle timers? Sinclair-Collins Model C-786 valves, diaphragm-operated by the source signal, assure near-instantaneous response for precise control of large pilot-operated valves and similar devices. They feature extremely short stem travel, from closed to fully open, and a flow area equal to ¼ in. standard pipe.

Space a problem? The Model C-786 measures but 5⅜ in. high . . . is only 3⅞ in. in diameter. Cost a problem? You'll find this valve, with all the built-in quality features found in every S-C valve, priced attractively.

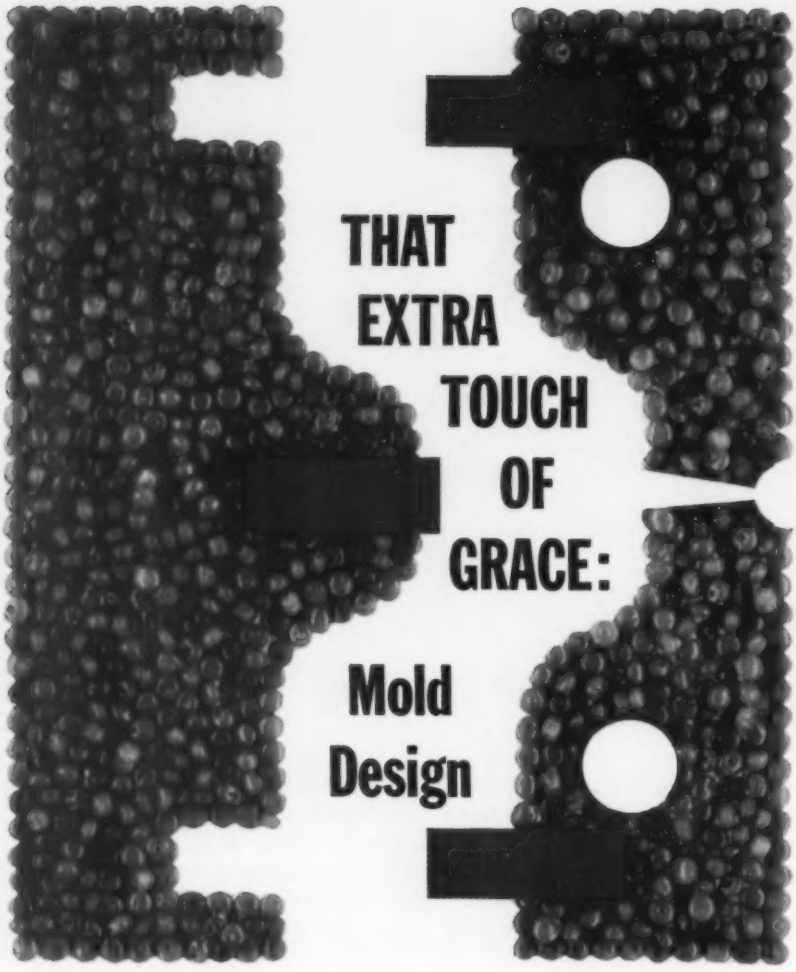
Models for air, steam, hot or cold water, or inert gas service; bronze, ductile iron or stainless steel bodies; 2 or 3-way; 20 to 50 psi signal, 125 psi main valve; tapped ¼ in. NPT. Ask your nearby Bellows-Valvair Field Engineer to show you how the Model C-786 fits your instrumentation control system.

8189-3

For more information, write for Bulletin 59-SC. Address Bellows-Valvair, Hydraulics Division, Salem, Ohio, Dept. MP-1261.

Bellows-Valvair
Division of IBEC SALEM 9, OHIO

These names assure you the best in pneumatic, hydraulic and electronic components
BELLOWS • VALVAIR • SINCLAIR-COLLINS • HUNT • HYQUIP • JACKSON ELECTRONICS



The shortest distance between drawing board and workable mold is not always a straight line. Why plunge ahead with new tooling without exploring all possible economies? Grace mold designers are experienced in juggling flow capacity, heat transfer, rate of fill and other factors to give that extra touch of Grace in mold design. This assistance is another of the ten major services available under the Grace Service Plan; ask your representative for details.

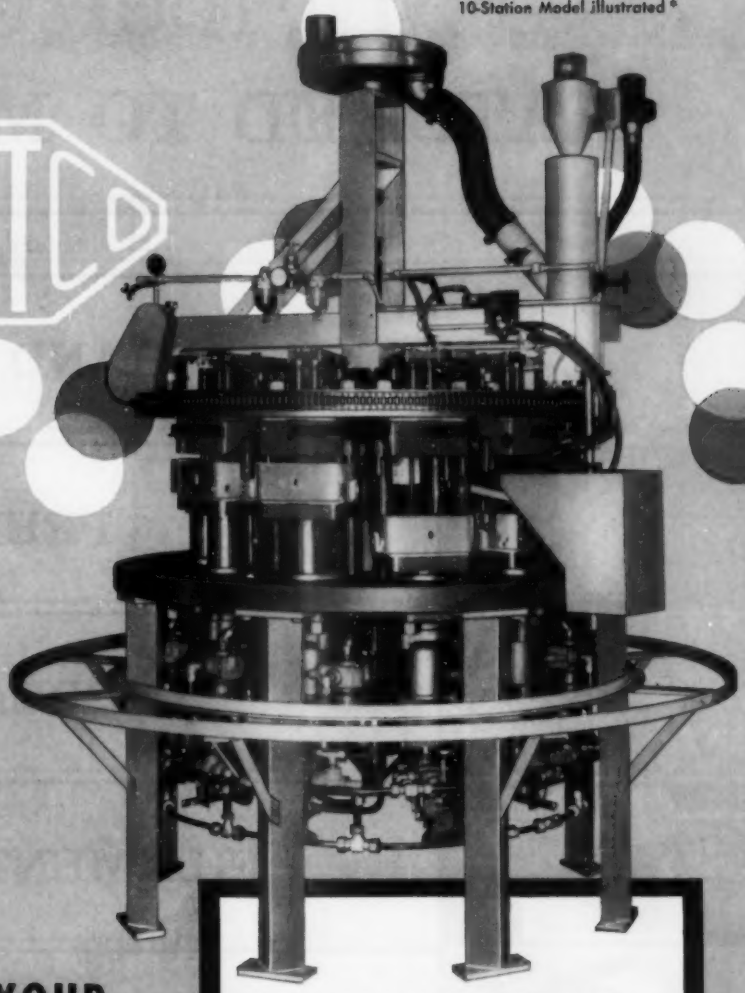
W. R. GRACE & CO. POLYMER CHEMICALS DIVISION, CLIFTON, N. J.

GREX® POLYETHYLENES · GRACE POLYSTYRENES · MOPLEN® POLYPROPYLENES · ®MONTECATINI TRADEMARK

GRACE
PLASTICS

NEBUTTCO

10-Station Model Illustrated *



AUTOMATE YOUR PLASTIC MOLDING OPERATIONS WITH NEBUTTCO ROTARY PRESSES

BIG-PROFIT FEATURES:

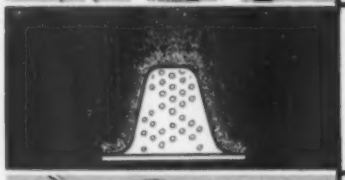
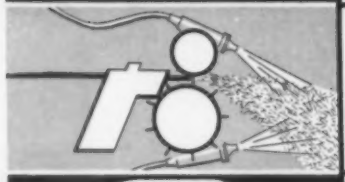
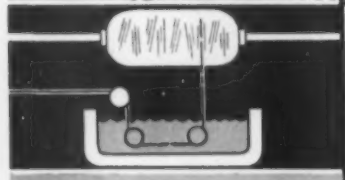
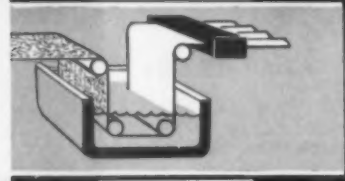
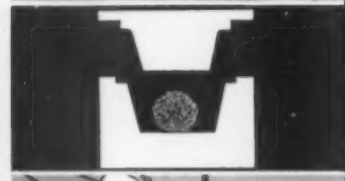
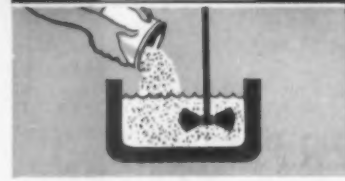
- Inexpensive molds, for thermosetting compounds
- Can use up to 20* different molds, one press
- Molds can be changed while press is operating
- Simple ejection of parts
- Hopper-fed — rotating supply
- Adjustable production cycle
- Adjustable temperature in mold holders
- Low cost molding of large or small quantities
- Presses can be furnished for many applications

For descriptive bulletin or demonstration of machines in operation, contact

NEW ENGLAND BUTT CO.
Division of Wanskuck Co.
304 Pearl Street • Providence 7, R. I.

Press is also made in 30-station model.

J-M Fiber Glass:
MATCHED TO METHOD

Molding Method or Application	
	HAND LAY-UP
	**PREFORM**
	**SPRAY-UP**
	**FILAMENT WINDING**
	**CONTINUOUS MOLDING**
	**PREMIX MOLDING**
	**POTTING, ENCAPSULATING and PUTTIES**

For top performance in lay-up and finished product—specify the J-M Fiber Glass product best suited to your molding method or application.

J-M Product	Outstanding Advantages to Molder or in End Product
GARANMAT	Fast wet-out. Superior wet-strength retention. Uniform fiber distribution. Compatible with polyester and epoxy resins.
GARAN® WOVEN ROVING*	Fast wet-out. High strength.
GARAN ROVING	Conforms well to preform screen. Fast wet-out.
CHROME ROVING	Easy to cut. Hard or soft types.
7170 GUN ROVING	Consistent performance. Static-free. No clumping. Soft, not stiff and wiry. Conforms readily to mold. Requires minimum roll-out.
8500 ROVING 1500 YARN	Epoxy-compatible. High, uniform strength. Positive, controlled tension. Zero end-out.
GARAN ROVING	Fast wet-out. Superior wet-strength retention. Compatible with polyester and epoxy resins. Imparts no color.
GARANMAT	Minimum fiber pattern. Imparts no color. Uniform distribution of fibers. Minimum variation in weight. Superior wet-strength retention.
GARAN CHOPPED STRANDS	Excellent physical and electrical properties. High wet-strength retention.
HDX FIBERS	Free-flowing, not clumped or nodular. Disperse readily in resin and remain dispersed.

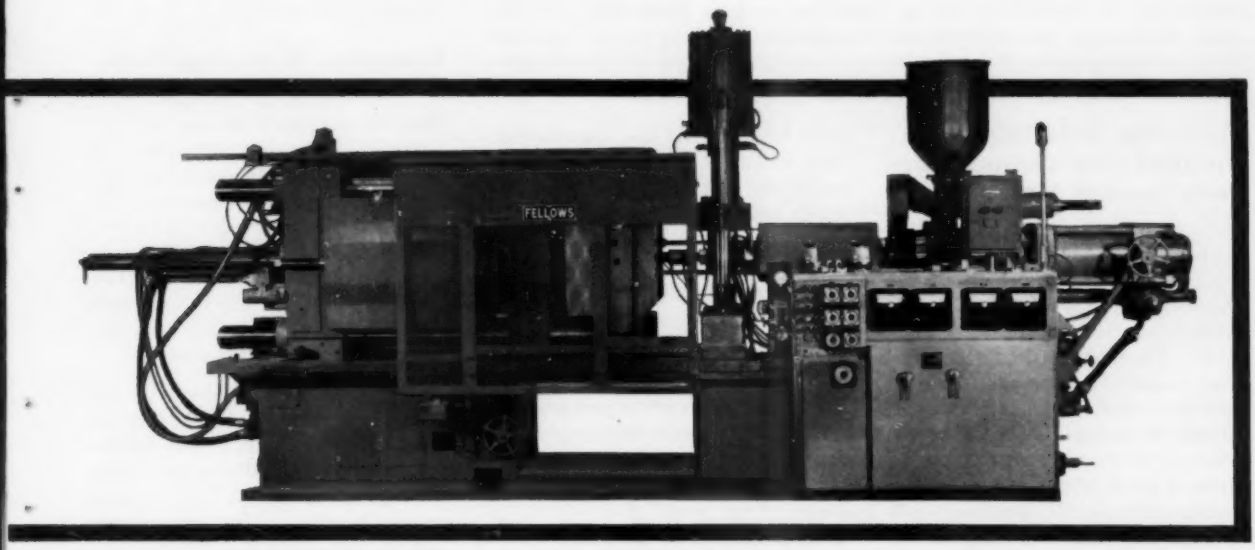
*Available from weavers

JOHNS-MANVILLE FIBER GLASS

JOHNS-MANVILLE JM PRODUCTS

ALL PRODUCED BY
FELLOWS MACHINES
. . . faster and with
fewer rejects!

Model	Rated Capacity	Maximum Mold Size	Locking Force	Mold Opens	Dry Cycles	Horsepower	Heater	Plasticizing Capacity
3-125	3-4.5 ozs.	12″ x 17″	125 tons	5″ — 8″	600 — 840 per hr.	15	6 KW	45 lbs. per hr.
6-200	6-9 ozs.	15″ x 21″	200 tons	6″ — 9″	490 — 650 per hr.	20	12 KW	75 lbs. per hr.
6-225	6-9 ozs.	15″ x 25″	225 tons	8″ — 14″	600 — 700 per hr.	30	14 KW	100 lbs. per hr.
12-350	12-20 ozs.	20″ x 32″	350 tons	10″ — 20″	600 — 800 per hr.	40	21 KW	150 lbs. per hr.
16-20-450	Up to 20 ozs. with pre-pack	27″ x 34″	450 tons	10″ — 20″	700 — 875 per hr.	50	21½ KW	200 lbs. per hr.



Your Fellows Representative will be pleased to give you complete details.

SPI SOCIETY OF THE PLASTICS INDUSTRY

Fellows injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY *Plastics Machine Division:* Head Office & Export Dept., Springfield, Vermont
Branch Offices: 1048 North Woodward Ave., Royal Oak, Mich. • 150 West Pleasant Ave., Maywood, N.J.
6214 West Manchester Ave., Los Angeles 45, Cal.

NEW PRICE DECREASE

for the Industry's Best Low-Temperature Vinyl Plasticizers

Premium Performance of Plastolein® Azelates Now Available at Lower Price

Now, more than ever, you can benefit from the outstanding cold weather performance of Emery's Plastolein Low-Temperature Plasticizers. The recently announced price reductions bring azelate prices to an all-time low. Earlier price decreases this year followed last spring's drop in alcohol prices and the opening of Emery's new ozone oxidation plant.

Plastolein 9058 DOZ—Unequalled Low-Temperature Performance, Now 39c

The price of Plastolein 9058 DOZ has been dropped 2c to a new low of 39c per lb. (tankcars, East of the Mississippi). Long recognized as the outstanding low-temperature plasticizer, Plastolein 9058 DOZ offers great versatility in vinyls. It can be used as the sole plasticizer in applications requiring the most severe low-temperature performance because of its excellent compatibility. And its low volatility enables vinyls to maintain their low-temperature flexibility over extended periods of time.

In addition to the superior low-temperature properties which it imparts, Plastolein 9058 DOZ makes possible luxurious softness, drape and "hand" in vinyl film, sheeting and, especially, in coated fabric. It is this combination of outstanding hand, drape and low-temperature properties that is responsible for the wide use of 9058 in the new vinyl foam fabrics. 9058 also has excellent heat and light stability, low water extraction and unusually low soapy water extraction.

Plastolein 9078 LT—Azelate Advantages, New Lower Price

Plastolein 9078 LT has been reduced an additional penny to 35c per lb. Yet, it features azelate permanence: low volatility, good resistance to oil extraction. Its low-temperature performance approaches that of DOZ.

Other Azelate-Based Plasticizer Prices Reduced

Price reductions extend to the other Emery plasticizers derived from azelaic acid. Plastolein 9057 DIOZ, similar to Plastolein 9058 DOZ and also an excellent low-temperature plasticizer for vinyls, is now 39c. Plastolein 9050 DHZ, which has wide use in high clarity applications such as vinyl film and sheeting, has been lowered to a new 45c level. DHZ is exceedingly compatible and efficient, allowing total plasticizer content to be reduced.

Complete Technical Data and Evaluation Samples

May we suggest that you make an analysis of possible advantage to you from using Plastolein Low-Temperature Plasticizers—especially in the light of these new and significant price decreases. Tangible upgrading of product quality or better costs, or both, are the rewards. Write for evaluation samples and complete technical information.

NOTE: All prices quoted in this advertisement are for tankcar quantities, delivered east of the Mississippi. Slightly higher prices apply for smaller quantities and to more distant locations. All prices are subject to change without notice.

Emery

Organic Chemicals Division
EMERY INDUSTRIES, INC.

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Vopcolene Division, Los Angeles, California
Emery Industries (Canada) Ltd., London, Ontario
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A BRESKIN PUBLICATION

MODERN PLASTICS

December 1961 Volume 39, Number 4

New elements in plastics distribution

In the Yellow Pages of telephone directories all over the nation, under the heading "plastics," is appearing a range of new business enterprises.

Sometimes they list themselves as distributors, sometimes as compounders, sometimes as jobbers or wholesalers, the nomenclature depending on the main function of the enterprise.

As plastics volume grows, as material makers tend more and more to concentrate on carload lots and standard runs, these new organizations serve to bring plastics and plastic know-how to other businesses in closest touch with the consumer.

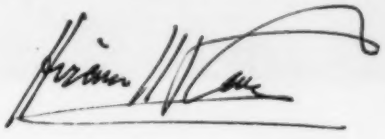
Take the case of the man who, with very small capital, decides to go into spray-up maintenance work, lining cracked swimming pools, damp-proofing basements, etc. He buys on time, or leases, his spray-up equipment and mounts it on a truck. His working capital is tiny, so he cannot inventory; but he can pay cash for small quantities. No maker of fibrous glass is interested in selling to him, on any basis, three spools of roving for a job. No maker of polyester or epoxy wants to sell him a 5-gal. order of resin and the proper amount of catalyst and inhibitors. But our new distribution enterprise will drop-deliver what he needs, and help him to use it properly.

Take the case of the custom molder who, to get a long-run and profitable job, agrees to mold only a thousand sky-blue-pink caps for cosmetic containers with flecks of gold added. This material would be a headache and a loss to any material maker and a nuisance to the molder. But our new compounders will make up the fancy plastic in 40-lb. quantities, for a proper price, and deliver it.

Take the case of the carpenter who goes into the business of converting drab basements into glamorous rumpus rooms. The customer has claustrophobia and wants a fake picture window. Our carpenter-builder can't get a sheet of ⅛-in. acrylic, 4 ft. by 6 ft., from the lumberyard. But he can get if from the plastics-yard, for cash.

Take the case of the chrysanthemum hobbyist, who needs 300 sq. ft. of scrim-reinforced polyethylene film under which to raise his gorgeous blooms. His local garden supply house would like to supply him. Again, the new type distributor will provide to the seed-and-bulb man not only the material needed, but information on how to use it economically—information which will be passed on to the hobbyist.

These new enterprises are next to the people who are next to the consuming public. They are important to the future of plastics.



Stable prices and growing markets, a variety of processing and finishing possibilities, an outstanding range of properties have long been features of the methyl methacrylates, and now the . . .

GLAMOUR PLASTIC

It has been said that the ultimate aim of the polymer chemist is to create the plastics equivalent of transparent stainless steel. If this is ever accomplished, the base materials will probably be the methyl methacrylates.

This year is the 60th anniversary, or Diamond Jubilee, of the first publication of a paper on these resins by Dr. Otto Röhm of Darmstadt, Germany. Our front cover reflects this plastics history.

But it was not until 1931 that methyl methacrylate resins were made available in commercial quantities in the United States. Since then their use has become so common, their beauty has been proven so durable, their applications so broad, their properties so well recognized that it is doubtful whether any other plastics have been as often seen and touched over the past 30 years.

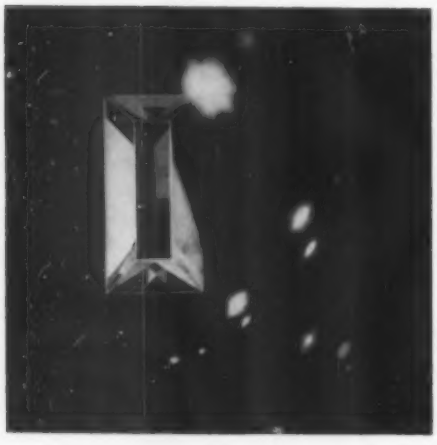
Used in applications ranging from dentures to huge displays and signs, from jewelry to architectural glazing, from brush backs to automobile tail lights, from appliance escutcheons to jet plane canopies, from embedments to bathtubs, MMA is the all-time glamour plastic.

The term "acrylic" is a generally used misnomer for MMA, which is the official and accepted alphabetical abbreviation for methyl methacrylate. The acrylics are many and many-propertied resinous spin-offs from an alcohol chain, involving acids, salts, and esters. This article is to deal only with MMA, made from methacrylic acid, in the form of monomer for casting, molding, and extrusion materials, sirups (graft polymers or blends of monomers and polymers) for reinforcement, and copolymers and alloys of the base material.

Everybody loves MMA. The molder, the caster, the extruder, the maker of reinforced architectural sheet, the industrial end-user, the consumer all enjoy its light transmission and other optical properties, its colorability, its ability to be decorated by metallization and paint, its impact resistance, its ability to be formed and oriented, its chemical resistance, its basic beauty.

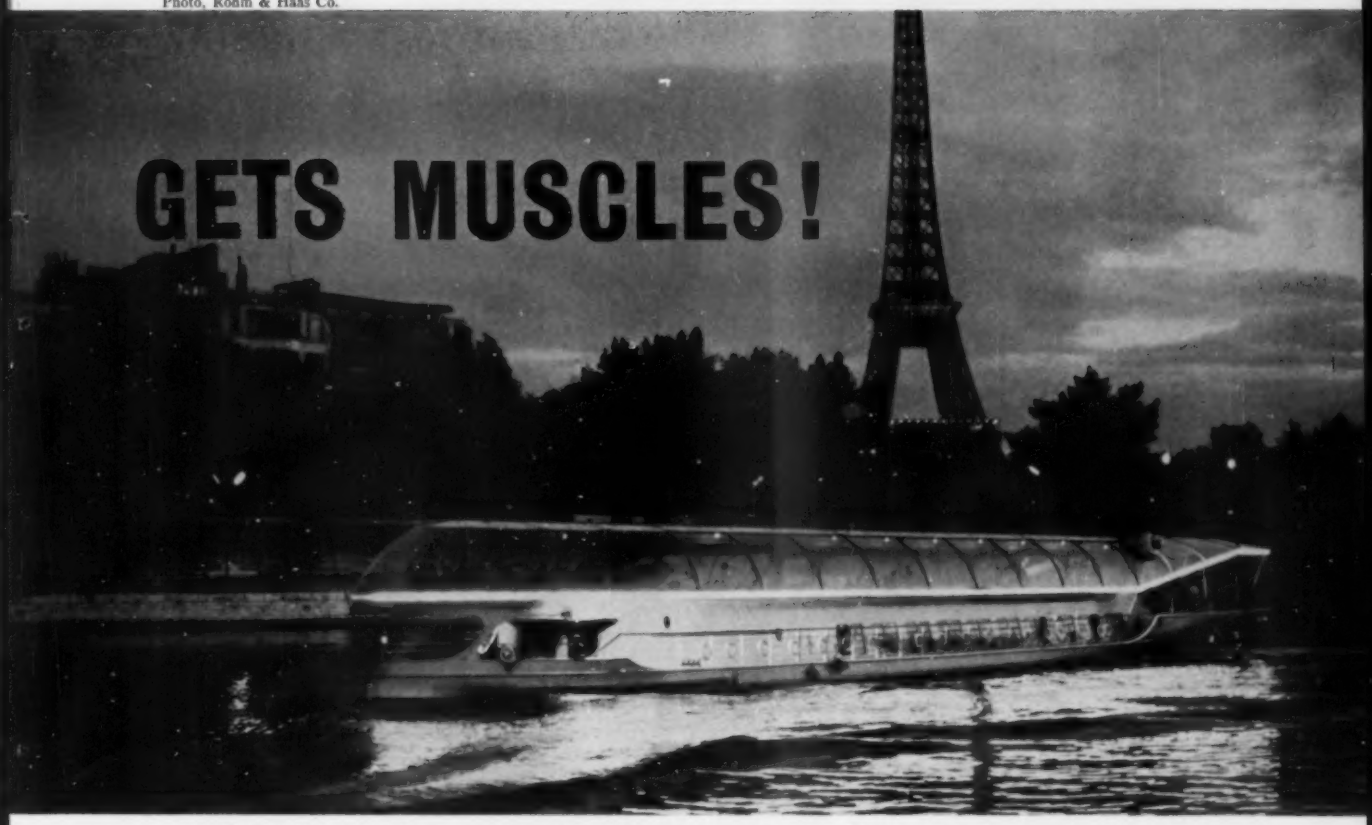
The material makers and the processors love it, besides, because of its price stability and, therefore, per-pound profitability. Since 1937, MMA molding material has dropped only from 85¢ lb. to 55¢/lb., while some other thermoplastics collapsed price-wise in the market. Volume in MMA continues to grow—and to grow profitably for everyone concerned.

Until now only two companies in the United States made MMA monomer and polymer. Du Pont Co. makes Lucite sirup for use in low-pressure laminating with fibrous glass reinforcement, monomer (Monocite) for casting sheet, and molding and extrusion powder. Rohm & Haas Co. makes monomer for casting, is itself the world's largest sheet caster (Plexiglas), offers monomer to other casters, and makes molding and extrusion material. Because only two companies were



COVER: The acrylic "diamond" is a perfect baguette that was designed and executed by Rohm & Haas Co. technicians, using gem-cutting techniques. A genuine diamond of similar perfection, size (6 by 3 by 3 in.), and weight (2,750 carats) would make a $2,750,000 Christmas gift.

Photo, Rohm & Haas Co.



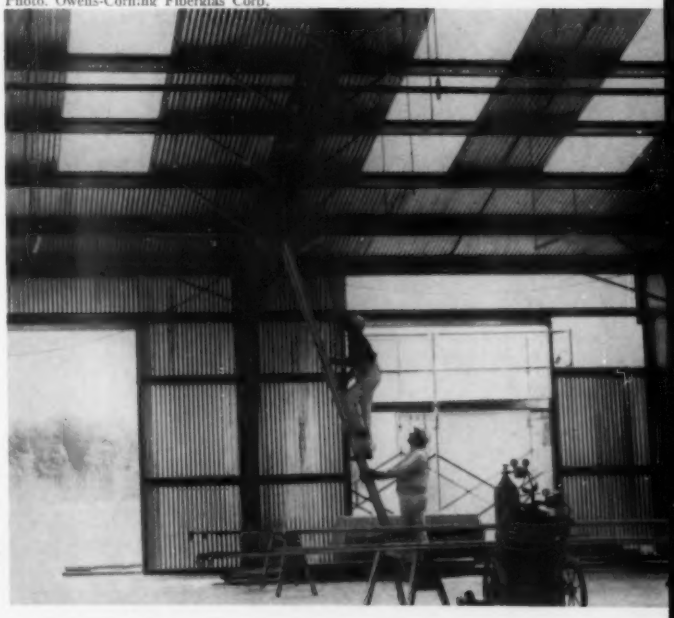
A TOUR BOAT, designed to carry several hundred tourists on the River Seine in Paris, is completely enclosed with flat and curved transparent methacrylate sheet.

involved up to now, no volume figures on MMA have ever been released, since the U. S. Tariff Commission groups them in its reports with other materials under the heading "Miscellaneous."

Now there are some added starters. American Cyanamid Co. has a license from Imperial Chemical Industries Ltd., to produce the equivalent of the British product, Perspex. J. T. Baker Chemical Co. has come up with a line of resins trademarked Bavick, about which more later. Escambia Chemical Corp. is in pilot production on a range of monomers, plus MMA molding and extrusion powders, and expects to be on stream early in 1963, having developed a new method of making methacrylic acid from alpha-hydroxyisobutyric acid via isobutylene oxidation.

Every company in the business, old and new,

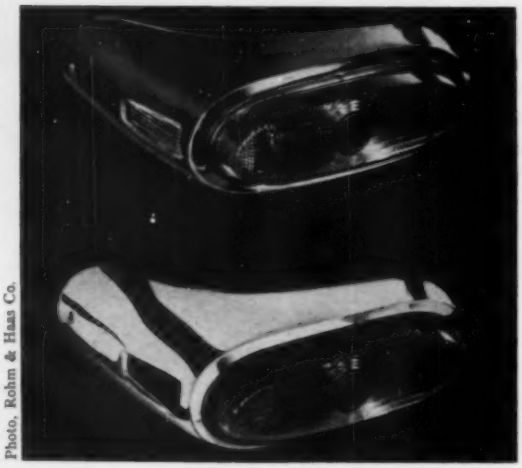
Photo, Owens-Corning Fiberglas Corp.



ACRYLIC SIRUP, reinforced with fibrous glass, is used to form weather-resistant translucent wall and roofing panels.

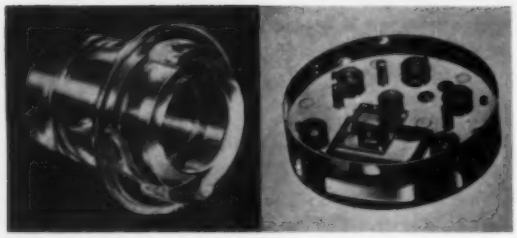
CAST ACRYLIC MONOMER forms panels in exciting light-diffused ceiling of this lounge.
Photo, Polycast Corp.

TWO-SHOT MOLDING produces red lens and transparent body of Lark tail light. Unit is then masked and transparent portion metallized on the inside, permitting MMA to replace, in one unit, both glass and metal.



Photo, Rohm & Haas Co.

BIGGEST SIGN JOB ever undertaken was replacement of more than 16,000 "Amoco" service station signs with "American" torch. Many fabricators were involved and control of quality and delivery schedules was a major effort.



INJECTION-MOLDED high-heat acrylic replaces glass in coffee percolator top and instrument parts. Photo, J. T. Baker Chemical Co.

Photos, Rohm & Haas Co.

has advised MODERN PLASTICS that it intends to adhere to present prices, because prospective markets at these prices are attractive. Of course, when volume gets big enough and competition tough enough, prices will be lowered—but probably not sharply and certainly not soon.

Then, through the addition of copolymers and alloys to achieve greater toughness, higher heat resistance and more resistance to abrasion (the historic Achilles' heel in MMA) all makers see new markets piled on markets, with profit for all.

For conventional cast or extruded MMA sheet, the obvious prime market is in architecture. It is significant that the New York City Board of

Standards and Appeals on October 17, 1961 accepted Plexiglas G for school glazing after 3 years of test installations, replacing glass protected by wire mesh. This is a slow-burning formulation and opens the road to huge installations, since it is also approved by the Building Officials Conference of America Inc.

Rohm and Haas Co. has added a line of opaque spandrel panel material for the building field, in nine favored architectural colors selected by sample survey, and mat-finished on one side.

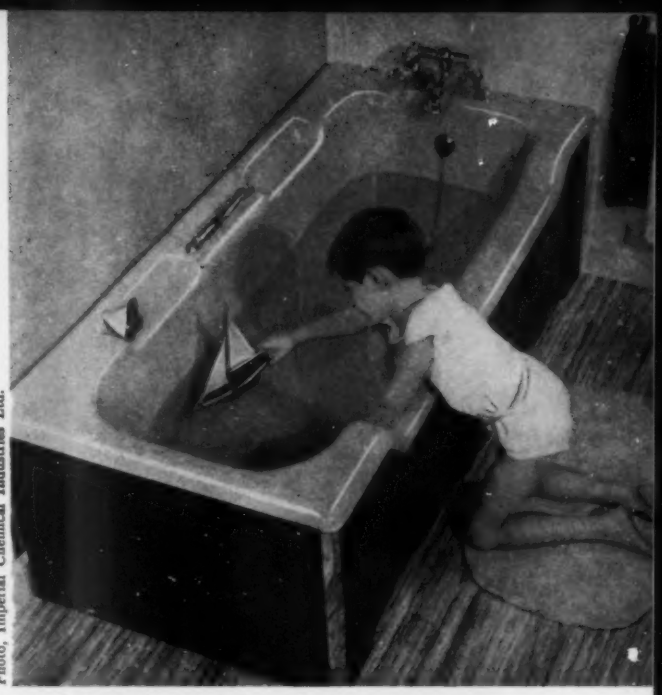
Also in the building field is the new trend in illuminating service stations. The MMA sheet in white replaces porcelain-enameled steel, and the whole structure lights up at night.

In England and in Australia, MMA sheet has been fairly widely used to form bathtubs and basins, but the idea has never caught on in the United States. The MMA tubs are light in shipping weight, highly impact-and-chip-resistant, warm to the touch, colorful—but they cannot take abrasive cleansers.

Still in the building field is the use of acrylic sirup with fibrous glass reinforcement and sometimes with various core materials, such as foams or honeycombs, to make structural panels. Two companies, Russell Reinforced Plastics Corp., and Owens-Corning-Fiberglas Corp., are currently producing sheet panels, either flat or corrugated, from glass mat and Lucite acrylic sirup. Chief reason is that the MMA material has reportedly better resistance to weather than other materials.

Another resin for the building panel field is Paraplex 444, made by Rohm & Haas Co. This is a polyester modified with MMA and is claimed to have higher heat resistance and better weather resistance than ordinary styrenated polyesters.

Next growing sheet market: signs! Thereby hangs a famous tale. Early this year Standard Oil Co. (Indiana), American Oil Co., and Utah Oil Refining Co. were assembled into a single marketing organization. The "American" torch and oval service station signs had to replace "Amoco" signs at over 16,000 service stations in 25 states—in two months. This was the biggest MMA sheet project to date and involved such fabricators as Plasti-Line Inc., Knoxville, Tenn.; Tel-A-Sign Inc., Chicago; Neon Products Inc., Lima, Ohio; and Spangler Sign Corp., Philadelphia, all working



Photo, Imperial Chemical Industries Ltd.

BRITISH BATHTUBS are being mass-produced from thermoformed acrylic sheet.

ONE-HUNDRED-FT. spectacular sign required 1510 sq. ft. of methacrylate sheet.
Photo, A. S. Spark Plug Div., General Motors Corp.

Photo, Rohm & Haas Co.

HOUSING of milk-flow meter made of impact acrylic copolymer is completely sanitary, weighs just half as much as former steel unit.

METHACRYLATE-STYRENE COPOLYMER was molded to form this screen facade on remodeled building. Photo, Dow Chemical Co.

DOOR HARDWARE becomes a luxury proposition when tooled from cast block methacrylate. Photo, Imperial Chemical Industries Ltd.

under the direction of Trade-Marketers Inc., Knoxville, coordinators of the project. It would gladden the heart of any MMA salesman to see thousands of old signs on city dumps, replaced by sparkling new units advertising "American."

The same thing happened when Standard Oil of California turned to "Chevron," and Hy Finn, on television, wanted to know what happened to the old service station signs. The same thing is happening now at Humble Oil-Esso stations. A revolution most profitable for makers, casters, extruders, and fabricators of MMA.

The sign business is closely linked in techniques to the building field. Both involve structural engineering projects (a rotating service station sign has to be tested by powerful fans or similar devices), but either cast or extruded sheet may be used. And sign making is a big and growing business for sheet casters and extruders. In general, according to Cadillac Plastic & Chemical Co., Detroit, which has 22 sales offices, the "production" signs in large quantities are made of huge thermoformed sheets of MMA, painted with translucent acrylic enamels on the inside. Occasionally, where specified, colored transparent MMA is used and the letters are cut out and bonded to the shell. But in "custom" signs (one or two to a customer) the sign builder makes a "box" of metal, faces it with MMA sheet, white or colored, corrugated or plain, cuts out the letters in another translucent color, and then adheres them onto the face of the "box".

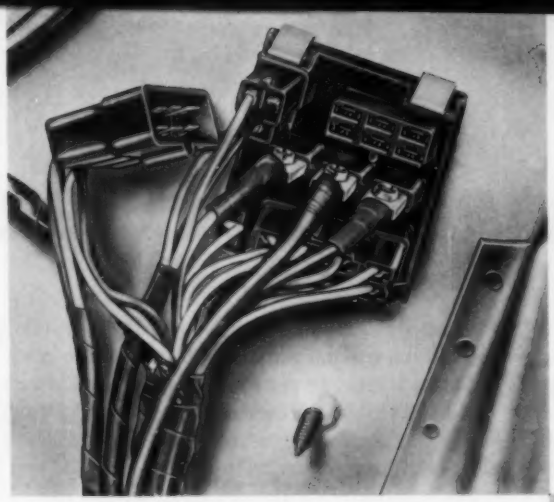
Another facet of the sign business is the production of stock letters (see MPI, Sept. 1957, p. 140).

Other developing markets

Still other markets for sheet materials are airplane canopies, boat windshields, shower stalls and doors, skylights, and the possibility of an automotive market. Out of the work done by Swedlow Inc., Los Angeles, and Goodyear Aircraft Co., Akron, Ohio, on biaxially stretch-forming MMA sheet have come some superior materials for supersonic jet plane canopies, strong and optically correct. Boat windshields and windows present no such problems, but account for probably 2 million sq. ft. of MMA sheet per year. One of the biggest factors in the shower stall business is Wasco Products Inc., a department of American Cyanamid Co., producing—in three plants in the United States and one in Canada—cast sheets with gold mesh embedments, leaves, fabrics, butterflies, ferns, and other built-in decorations.

Coming to the automotive market for sheets, work is progressing on stretch-formed, glass-skinned MMA for windshields. **(To page 160)**

SIMPLIFIED WIRING IN '62 CARS



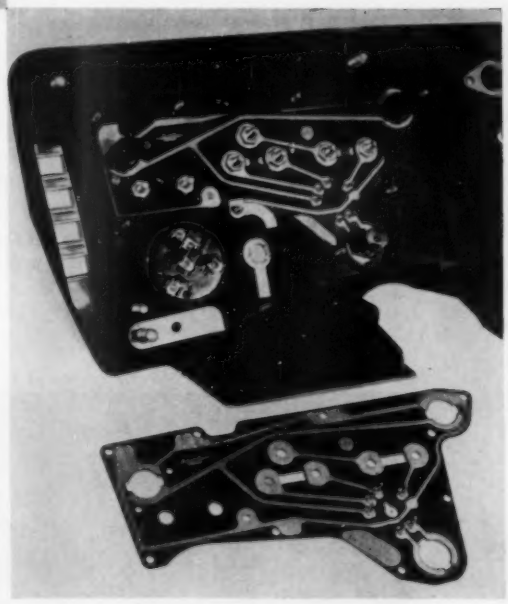
WIRING CONNECTOR—filled polypropylene

It may seem strange, at this stage of the game, to be talking about something as universally accepted as plastics in automotive electrical parts—but a quick look at Chrysler Corp.'s 1962 cars shows two basic departures in plastics usage that is attracting attention in other industries.

One innovation involves increasing use of filled polypropylene (which, incidentally, is also under serious consideration for such larger parts as instrument clusters and garnish moldings). There are two parts molded of this material in the 1962 models—and note in each case the emphasis on simplification and economy through redesign based on filled polypropylene's outstanding electrical properties: rigidity, moldability, and high-heat resistance.

One of the parts is a fuse box (with snap-on removable cover also molded of filled PP) which mounts in the back of the car's instrument panel for the same ease of accessibility that characterizes the use of fuse boxes in the home. The second PP part is a unique bulkhead wiring connector. This component collects all the passenger compartment wiring in a single multi-circuit "block," which snaps into the dash panel, where it can be connected by a simple plug on the engine side of the wall. In this way, assembly is simplified, service costs are reduced, and the "rat's nest" of wires traditionally found behind the instrument panel is eliminated. It should be noted also that, in both cases, all necessary electrical contacts are molded into the part—no supplementary insulation is needed.

The second basic innovation involves a new approach to printed circuitry—certainly one of the fastest-moving trends in Detroit today. For the Chrysler job, the circuits are used for the electrical lines in back of the instrument cluster and are die-stamped on a special phenolic-paper laminate which is bonded in turn to the back of the cluster—quickly and efficiently.—**End**



PRINTED CIRCUIT—phenolic-paper laminate

FUSE BOX—filled polypropylene

POLYCARBONATE FOR

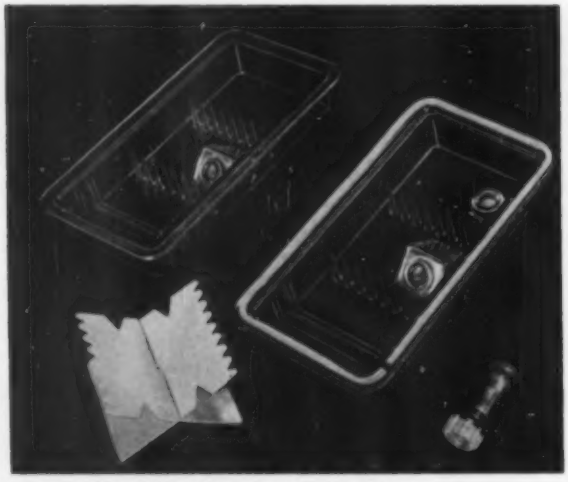
The thought of disposable polycarbonate—at a resin price of $1.30/lb.—may at first glance seem preposterous. Nevertheless, when the material was specified in a recently developed blood oxygenator as a replacement for several stainless steel and stainless steel-glass components, the resultant savings were so great that the polycarbonate parts are now classified as optional throw-away items.

How costs compare

There are three major components where polycarbonate replaced metal or glass: 1) an open-heart suction return filter—which accepts blood from a syphon line linked to patient's heart; 2) oxygenator disks—a series of these in a cylindrical chamber revolve to infuse the blood with oxygen; and 3) a bubble trap—which has a mesh filter to remove dangerous bubbles from the blood before it returns to the patient's body (see photos below). In addition, there are also several fittings where the materials were switched. Respective prices for the units are as follows:

	Steel/glass, $	*Polycarbonate, $*
Oxygenator disk, convoluted	5.00	0.18
Bubble trap	500.00	15.00 (plus $45 clamping ring)
Open-heart suction return filter	450.00	20.00
Tube fittings	4.00	0.75

These are initial costs only. Clean-up with previous units was another expensive and constantly



FILTER HALVES with PE baffle and fitting

BUBBLE TRAP parts with nylon nut

FILTER AND BUBBLE TRAP are each formed of identical molded halves. Polycarbonate fittings are positioned in machined holes and held in place with nylon nuts. Filter baffle plate is made of two pieces of polyethylene notched together.

THROW-AWAY PARTS

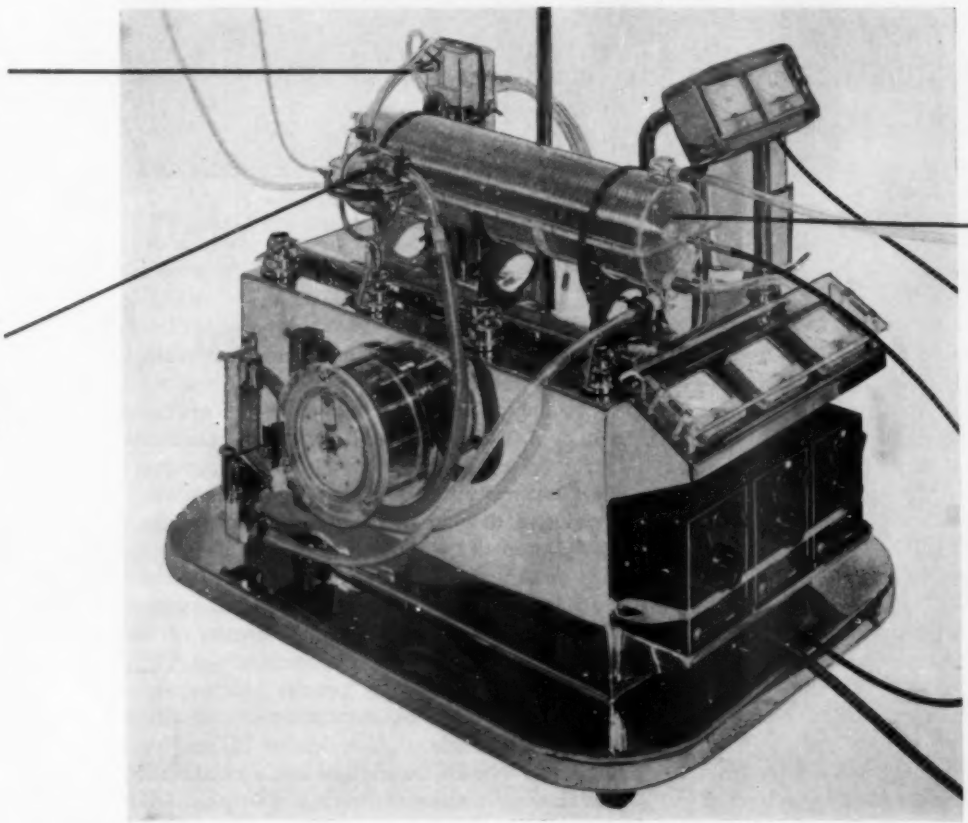
Despite the material's high per-pound price, parts molded from it for use in a heart-lung machine are so much less expensive than previously used metal that they can be discarded after a single use

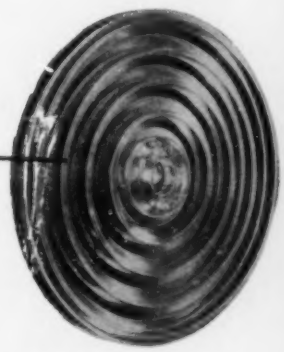
recurring operation: It took two full working days for one technician, plus the time of one operating room nurse. And even at that, the hospital could not be absolutely sure that contamination was not reintroduced into the oxygenator equipment prior to its next use.

By specifying polycarbonate parts, both the contamination and labor problems are overcome. The components are just thrown away, or perhaps reused in laboratory studies on animals. And because of the low cost of the polycarbonate parts, hospitals can now stock an inventory to meet multiple emergency operations. The expense of stainless steel parts generally made it prohibitive to keep extras on hand.

In terms of performance, convoluted oxygenator disks offer much more surface area than flat units. In fact, they increase oxygenator **(To page 167)**

POLYCARBONATE PARTS are shown in position and in close-up. In order of use during blood cycle they are (top left) open heart suction return filter; (right) oxygenator disk, one of 50 used; and (bottom left) bubble trap.

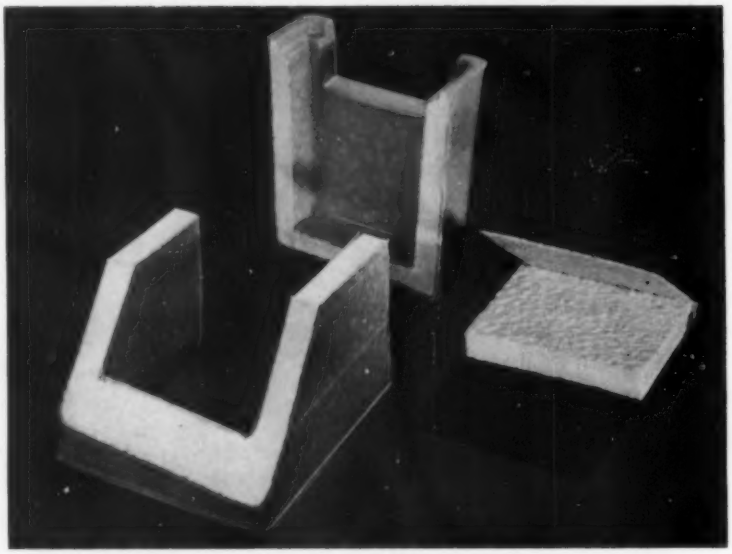




TWO PIPS near center of convoluted disk fit into matching depressions on rear side of next disk, linking all 50 into one component turned by the central rotating shaft.

PS FOAM WITH PE SKIN— FROM ONE MOLD

Surface appearance, hardness, and colorability are all upgraded through one-phase molding of PE coating and expandable styrene beads



CUT-AWAY VIEW of sections of ice chest (at top) shows how closely polyethylene skin clings to polystyrene foam, even to the extent of picking up expanded bead pattern on underside.

The ice-cube container illustrated above may not look particularly unusual or exciting. But don't let looks deceive you. Actually this simple-looking product represents a major breakthrough in polystyrene (PS) foam technology. It is a molding that consists of a foam core completely surrounded by a continuous, one-piece skin of polyethylene (PE)—*and both core and skin are molded at the same time, in the same mold, as part of the same cycle!*

The significance of this development is clear. Despite its many good properties (light weight, good insulation, moldability), expandable PS has, heretofore, had tough going in those areas where, in addition to these properties, good surface appearance, hardness, and bright colors were also required. The new construction surmounts these shortcomings, and thus opens up new market vistas for PS foam.

Moldings of PE-skinned polystyrene foam have a smooth, glossy surface. They can be produced in any color, from light pastels to brilliant hues. They are not brittle. And they are strong.

In effect, they are modified sandwiches exhibiting the strength traditionally associated with sandwich construction. As a matter of fact, this unusual process makes it possible to produce an item without appreciably increasing the density of the finished product of one made solely of foam.

Details of the molding process are a closely guarded secret. But basically what is involved is this: Finely powdered high-density PE and expandable PS beads are charged into a mold which goes through a series of ovens, **(To page 165)**

PART III[a]

POLYPROPYLENE:

What should film users look for?

The potentialities of PP as a film have long been recognized, but problems have been many. Now improved properties, contributed by new formulations and processing techniques, bring it into closer competition with other films. Here is the how and the why . . .

Photo, AviSun Corp.

When polypropylene (PP) resin was first introduced on a commercial scale, its potentiality for use as thin film was immediately recognized. A combination of fine properties give it desirabilities probably unequaled in any other film material. It has low density; high tensile and impact strength; heat resistance greater than in any other low-cost plastic; good stiffness; high surface gloss and hardness; excellent resistance to chemicals; low moisture vapor transmission; resistance to environmental stress-cracking; dielectric properties as good as any, and better than many other, plastics; and extreme toughness combined with superior flex strength.

And above all, nearly everyone believes that the price of PP film is subject to an eventual decline that will make it competitive with other low-cost films at least on a price-per-square-inch basis. Some producers already claim that even now it costs less than cellophane and will eventually match polyethylene (PE), when one considers that it can be used in thinner gages and thus give greater yield per pound.

But prospective users, however interested, have been impatient about PP film's failure to suddenly sweep into the market—despite the fact that all other films except PE also required several years before they became widely accepted.

It is estimated that only a few million pounds of PP film were consumed in 1960; the total for 1961 may not be over 15 million pounds. Estimates on consumption in 1965 vary all the way

[a]This is the final article in an across-the-board study of PP. Part I, concerning the development of the resin, its general properties, and an analysis of future markets in terms of capacity and prices, appeared in August. Part II, reporting on the properties, processing techniques, and applications of PP as a molding material, appeared in the October issue of this magazine.

from 50 million to 150 million pounds. One film expert says that—unless price, processing, and machine handling problems are overcome—it won't even reach 50 million pounds. On the other hand, he reports, when such problems are overcome, consumption can exceed 150 million lb. per year *if* the markets for which it is presently aimed are captured.

Presently PP film is used primarily for sheathing cable and wrapping phonograph record albums, paper products, and bread and other bakery products. Several chain bakers are using more and more of it after initial try-outs. Still others are cautiously eyeing its progress. Apparent adoption of the film in several areas now indicates that preliminary development has reached a stage where commercial applications and intensified marketing campaigns should start to take hold in a substantial way. There is plenty of film resin capacity. In fact, a surplus is now available; and, if film consumption in a big way doesn't start soon, resin producers are going to be most unhappy.

There are several reasons for PP film's slow start. One of the chief factors is that producers of PE film, who did the first experimental work with PP, tried to use the processing techniques with which they were familiar. These didn't work, but enough of the film got to market to cause dissatisfaction and pessimism among end-users. Even though it is a polyolefin like PE, PP behaves quite differently on a film-making machine and requires different pressures, temperatures, control devices, running time, chilling, take-off technique, and general handling operations. One processor says: "We finally got wise and threw out the book we used for PE—now we are writing a new one."

Another reason that perhaps held back more rapid development of PP film was that nearly all the principal film producers had big investments in other types. This made them cautious about moving into PP film production until PP was a proven material that would be acceptable and competitive in marketing areas in which other films are now well-established. The plastics industry is studded with this type of experience—processors and producers alike spend hours of time and thousands of dollars before they master

Table I: Comparison of competitive films

Film identification	Yield $in.^2/lb.$, 1 mil	Cost ¢/1000, $in.^2$	Tensile strength, p.s.i.	Percent elongation, %	Tear str. Elmendorf, g./mil	Maximum use temp., °F.	Minimum use temp., °F.	Heat-seal range, °F.	MVT. g./24 hr./100 $in.^2$, 1 mil	Gas transmission cc./100 $in.^2$/24 hr./mil		
										Oxygen	Nitrogen	Carbon dioxide
Unoriented PP	30,900	2.3	3,500 to 5,000	400 to 600	40 to 330	280	−20	325 to 400	0.5 to 0.7	200 to 300	30 to 100	700 to 800
NC-coated cellophane	19,500	3.2	7,000 to 16,000	15 to 25	2 to 10	Chars at 375	0	200 to 300	0.2 to 1.0	Dry = Low Moist = Variable		
Saran-coated cellophane	19,500	4.1	7,000 to 13,000	25 to 50	7 to 15	Chars at 375	0	225 to 350	0.5 to 0.9	Very low		
Low-density polyethylene	30,100	1.6	1,350 to 2,500	50 to 600	150 to 350	180	−60	250 to 350	1.2	500	200	1350
Med.-density polyethylene	29,600	2.1	2,000 to 3,500	50 to 500	50 to 300	180 to 220	−60	240 to 350	0.5 to 1.0	—	—	—
High-density polyethylene	29,000	2.1	3,000 to 4,500	50 to 400	15 to 300	230	−60	275 to 350	0.3 to 0.6	100 to 150	50 to 60	300 to 400
Oriented polystyrene	25,400	2.4	9,000 to 12,000	10 to 20	20 to 30	Shrinks at 185	Sub-zero	250 to 325	4.4	200 to 300	40 to 100	500 to 1000
Vinyl chloride	21,500	3.4	3,000 to 11,000	5 to 250	Varies widely	Approx. 200	Depends on plasticizer	200 to 350	4 to 13	100 (est.)	25 to 50 (est.)	500 (est.)
Rubber hydrochloride ¾ mil 1 mil	33,000 24,750	3.3 4.5	5,500 to 7,500	350 to 500	60 to 1600	Softens at 200	Depends on plasticizer	250 to 350	0.5 to 15	Low to high		
Polyester	20,000	11.2	17,000 to 23,000	70 to 130	13 to 80	230	−80	275 to 400	1.0	5 to 10	0.50	7.30
Cellulose acetate	22,000	3.4	7,000 to 12,000	15 to 50	2 to 15	Approx. 300	Brittle at sub-zero	350 to 450	100	100 to 140	25 to 40	500 to 800
Saran	16,300	6.6	8,000 to 20,000	40 to 80	10 to 20	Softens at 290	Good flex at 0	280 to 300	0.1 to 0.3	0.1 to 0.2	0.025	0.30

Interpretations: Cost figures are subject to quick change. Those printed here are several months old. MVT column—the lower the numbers, the least moisture transmission. Gas transmission column—oxygen should be withheld from meat, but not necessary in cooked meats. Carbon dioxide sometimes used in packaging fruits and produce.

the new techniques required whenever a new resin is introduced to the industry—and after all, PP is barely 4 years old insofar as sizable commercial production is concerned.

Another complaint frequently uttered by pioneers in PP film development was that it was almost impossible to obtain uniform batches. But this problem is being overcome as producers gain experience and begin to use special blending techniques and continuous production instead of the batch method.

Formulators tailor film properties

Resin producers were also quick to recognize that a general-purpose resin that might be used interchangeably for film, molding, monofilaments, etc., is practically an impossibility in PP. Each use requires its own grade. And, as usual, stabilization problems must be taken into consideration. A stabilizer system used in one grade is not suitable for another—properties change with the stabilizer. Thus, the stabilizer used in formulating a resin for use in making a food-grade film is not likely to be used in formulations where higher temperatures are required in processing.

Production know-how in resin producers' plants has also gone through a rather rigid evolution. By varying molecular weight (*m.w.*) and molecular weight distribution (*m.w.d.*) in polymerization, producers can alter formulations for specific markets, *e.g.*, for film, for molding, etc. They even vary formulations within each end-use bracket. Thus, the higher the *m.w.* the lower the flow rate and the tougher the film that can be made therefrom. Yet, if the *m.w.* is too high, the resin is almost impossible to handle, and if too low the film will surge when coming from the extruder in an uncontrollable manner. The first film-grade resins were of high *m.w.*; now they are made with a lower weight to obtain a lower viscosity. In paper coating, for example, the high-flow rate obtainable with resin of low *m.w.* is needed, but, of course, some of the other properties of PP must be sacrificed.

Producers state that the *m.w.d.* of resin is even more important in determining properties of film made from it. But all this chemists' nomenclature is practically meaningless to a non-chemist. It is sufficient that the end-user know enough to understand two things: 1) that PP can be varied according to a wide vista of end-use products and, 2) that film-grade resin today, now that the various troubles in production of film have been identified, is a very much improved material. Such considerations of the effects of variations in *m.w.* and *m.w.d.*—the exact tailoring of which is determined by the skill employed in polymerization—explain why one producer's resin differs from another's.

Photo, Hercules Powder Co.

BREAD WRAPPING is proving a growing market for unoriented film in both the U. S. and Europe. Film's sparkle, clarity, and relatively low cost in thin gage used were important factors in this market.

Photo, Versapak Packaging Machinery Corp.

SHRINK PACKAGING is winning markets for oriented film. Maker of this staple gun is testing it over previously designed carton, says it eliminates 95% of package damage.

Price will help determine the future

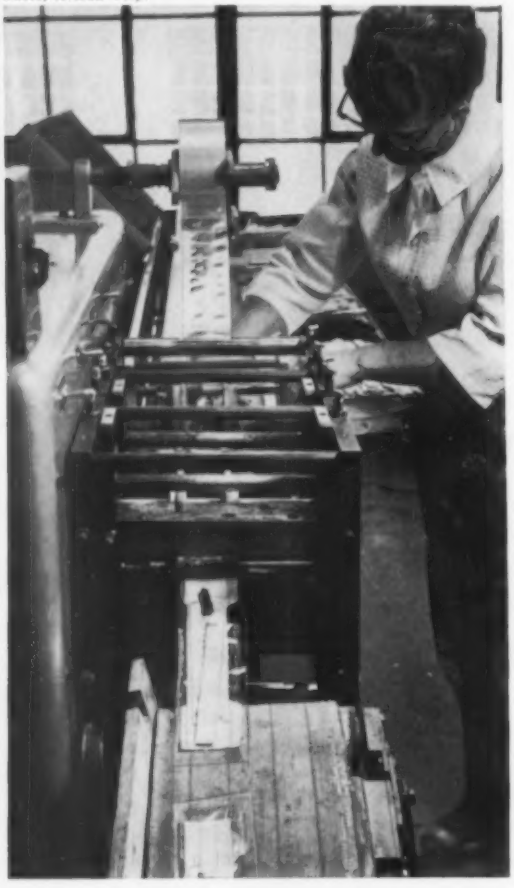
The present and future volume use of PP depends to a great extent upon cost and no one knows when resin prices will decline. However, it is almost a foregone conclusion that PP prices at some future date will be within a few cents of PE; and, since PP is lighter in weight, the greater yield of film per pound of resin should bring the

Table II: Comparison of oriented PP and oriented-coated PP film*

	Oriented polypropylene	Oriented and coated polypropylene
Thickness, mils	0.5	0.65
Density	0.90	1.00
Cost, $/lb.	1.52 to 1.75	1.40
Yield, sq. in./lb.	61,400	40,000
Cost, per 1000 sq. in.	2.5 to 2.9¢	3.5¢
Gloss, %	60 to 65	68 to 75
Clarity	91	87
Tensile strength p.s.i.		
Machine direction	8,000 to 10,000	8,000
Transverse direction	13,000 to 35,000	22,000
Tear, g.	10 to 20	6 to 8
Stiffness	3.50	3.25
Typical heat-seal range, °F.	300 to 310	250 to 350
Typical heat-seal strength, g./in.	Poor	150
WVTR, g.	0.63	0.4
Oxygen trans., cc.	200 to 300	—

*From a paper presented at a Food Packaging Seminar of the Packaging Institute, Oct. 1961, by F. B. Shaw Jr., Continental Can Co.

Photo, AviSun Corp.



HANDLING PROBLEMS are disappearing as wrapping machinery is designed with PP film characteristics in mind. Here parts of toy glider are wrapped and sealed in assembly-line fashion.

final costs of the two films nearly equal. Producers assert that, even at present prices, PP film costs less than cellophane and approaches the cost of PE when weight is considered. For example, it is claimed that a PP film ½- or ¾- mil thick will compete with a 1½- or 1¼-mil PE both property-wise and cost-wise and also can be handled just as well on a wrapping machine. Of course, if both films are of the same thickness, PP may always be priced higher.

Any quotation of prices at present is dangerous to print since they can be changed overnight. Allowance must also be made for such factors as concessions to users for development or promotional purposes. Moreover, when comparing PP film with cellophane, it must be noted that some price declines apparently are under way for the latter material. In delving into this complex situation, even at the risk of a possible error, we are attempting to give only a broad comparison of prices so that the reader may have a fair idea of what is happening.

PP prices vs. those of other films

PE film for packaging is listed at about 46¢/lb. —but, allowing for all discounts, it is said to be closer to 42¢ in reality. One lb. of 1-mil PE film yields approximately 30,000 sq. in., which makes its cost about 1.4¢/M sq. inches. A 1-mil cast PP film at 64¢/lb. will yield about 31,000 sq. in., or cost about 2¢/M sq. inches. An 0.870-mil PP which will provide 35,500 sq. in./lb. of film costs about 1.8¢/M sq. in., which is still more than 25% higher than 1-mil PE.

There is some talk that 1-mil PE film is not thick enough for many packaging uses. On the other hand, some producers contend that a 0.750-mil PP film is sufficiently thick for wrapping soft goods, bread, etc. But the present largest marketer of PP cast film says that 0.870-mil is necessary for handling on a wrapping machine, especially in hot, humid atmospheres. Cellophane of this type generally has cost around 3¢/M sq. in. —up to now anyhow—so it is easy to see why PP is shooting particularly at that market. PP is not as stiff as cellophane but it is heat sealable, although users have to modify wrapping machines that were built to handle cellophane.

While it is expected that PP resin will gradually decline in price, and thus increase its com-

petitive capabilities, in all probability PE has not yet reached its potential lowest cost either. The cost spread between resin and film is now much more favorable for PP: resin costs 44¢/lb.—thus a film price of 64¢ gives a 20¢ spread. The price spread in PE is 14.5¢, when film price is 42¢ and resin price is 27.5¢, but there are all kinds of variations in this spread since there are so many different prices for both resin and film. However, European producers are selling PP film in direct competition with PE for wrapping bread, paper products, and textiles, despite PP's higher price, primarily on the basis of its superior sparkle, clarity, and abrasion resistance.

Oriented film may become PP leader

The above PP prices apply only to what the trade calls cast film. Biaxially oriented film costs more, but, here too, present prices are variable. One comparatively new producer set introductory prices of $1.15/lb. for 1-mil film, $1.40 for ¾-mil, and $1.65 for ½-mil. The last yields 62,000 sq. in./lb. of film. At that price, it is said to be less costly than cellophane and is expected to drop in price as fast as markets develop.

There are film producers who believe that 70% of all PP film will eventually be biaxially oriented. Not everyone will agree with them since so-called cast film will probably always be a bit less costly and there is every reason to believe it will improve in quality as fast as the technicians improve their techniques for making resin and film.

Orientation is achieved by stretching the film during production. A separate stretching, or orienting, operation gives film four to eight times more tensile strength and may be done in either machine or transverse direction, or both. (Cast film is stretched only slightly in the machine direction.) Oriented film is generally coated, *e.g.*, in some cases with vinyl acetate. Originally such coating blocked in humid weather, but now it has been modified. Other coating materials may eventually supplant vinyl acetate. Without a coating, oriented PP will shrink back to its original form when heat is applied from sealing equipment.

Any oriented PP film is stiffer and stronger than cast film. Its ability to remain flat and undistorted regardless of variations in humidity, temperature, and age are notable. Consequently, use of oriented ½-mil film may be more satisfactory than a thicker unoriented PP or PE film. As noted from prices above, an uncoated ½-mil biaxially oriented PP is now priced at about 2.7¢/M sq. in., compared with 1-mil cast PP at around 2.3 or 2.4¢, but its advantages in certain types of machine handling are thought to outweigh the extra cost. Note that the oriented PP is still more costly than PE and that it must, at least for the present, compete on a basis of offering better performance.

The largest use so far developed for oriented film is as a shrink film for wrapping various articles. Orientation gives the film a natural built-in shrink because application of heat will cause it to shrink back to the normal dimensions that it had before orientation. It can be wrapped loose and then shrunk tight around almost any package. A ragged cut-off is not harmful; it doesn't have to meet such close tolerances or critical gage thickness; the film may vary slightly **(To page 170)**

Potential laminates markets for PP film*

Milk container stock: an appropriate first target. (Along with this usage, can be seen a general market area in the PP laminate replacement of certain metal and glass containers.)

Drug packaging: a single box of PP-laminated board stock to replace general drug containers where presently a bottle plus a box are employed.

Food packaging: here, three-unit construction is often employed—a liner, the box, an overwrap. A PP-coated stock would replace these three materials.

Carrying cases for bottles: beer and soda multipacks. Here moisture resistance and abrasion resistance of PP laminates would permit multiple reuse.

Chemical containers: PP's higher moisture, chemical, and heat resistance should prove important.

Food drum containers: here FDA approval, heat resistance, and greaseproofness become important features. The shipment of lard is an example.

Fabric laminates: an example—a construction to be used in a car interior as a liner.

Furniture cartons: toughness, abrasion resistance are important here.

Multiwall bags: here again the heat resistance, chemical resistance, moisture protection, and abrasive resistance of PP should be important.

Collapsible tube constructions: A possibility of economy, lightweight usage.

Freezer locker paper: in particular, for meat overwraps.

*Information in this table is supplied by Hercules Powder Co.

Nylon parts-large and

Industrial bearings, bushings, gears, and components of heavy-duty handling equipment take advantage of the economies inherent in new monomer casting process

Production of massive caprolactam nylon parts and shapes by application of techniques, and at costs, similar to those of metal castings is now opening up new markets for nylon in heavy industry, traditionally the exclusive domain of metal.

The technique, which is called monomer casting and is in a way similar to casting of acrylics, involves filling a mold with liquid caprolactam-based monomer, which then polymerizes, without the use of pressure, into a uniform solid product.

The two prime advantages of the process are:

1. Reduced raw material cost: nylon monomer sells for 46¢/lb.; standard molding-grade nylon material sells for 98¢ per pound.

2. Low tooling costs: Because of the absence of pressures during casting, mold costs are vastly reduced. For example, the injection mold for a 7-lb. part may run as high as $5000; a mold for a monomer-cast part of the same size would cost $500, and for certain items may be as low as $100. Similar relations hold true when comparing monomer casting with extrusion.

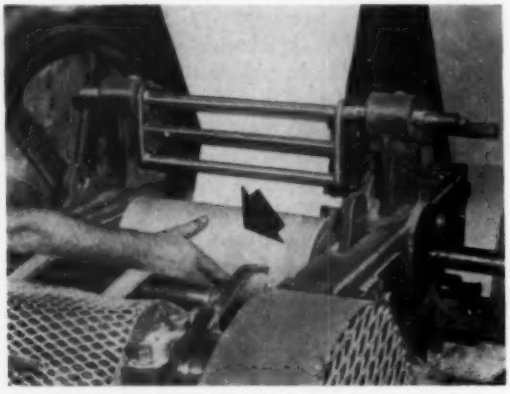
However, these economics apply only to large parts. Monomer-cast nylon is not expected to compete with injection molding in the production of smaller parts. For the latter, injection mold costs are low per unit of production and cycles are in the 15- to 30-sec. range. Monomer casting would require approximately 5 min. per casting cycle for small parts.

How do monomer casting economies translate into finished product costs, compared to metal castings? The table at right gives a direct comparison between a typical part as cast in nylon and in a variety of common foundry metals.

It is apparent that, at present prices, monomer-cast nylon is already substantially lower than identical castings in stainless steel, brass, or bronze; and the projected price of the nylon monomer is expected to put it even below mild carbon steel. In addition, nylon can generally be machined at higher rates than metal. Finally, it is not always necessary to maintain the close tolerances required for metal, because of nylon's ability to conform to mating parts.

Add to this the property advantages nylon

EXPERIMENTAL GEAR, measuring 4½ ft. in diameter, is exhibited by L. L. Stott, president of The Polymer Corp., to indicate the large size in which a variety of monomer-cast products can be economically produced.



BACK-UP ROLL (arrow) of MC nylon is used by Royal Lace Paper Div., Standard Packaging Corp., in the production of paper doilies. Nylon replaced compressed kraft paper rolls, resulted in an annual saving of $2000 per roll, since one nylon roll outwears 50 paper rolls.

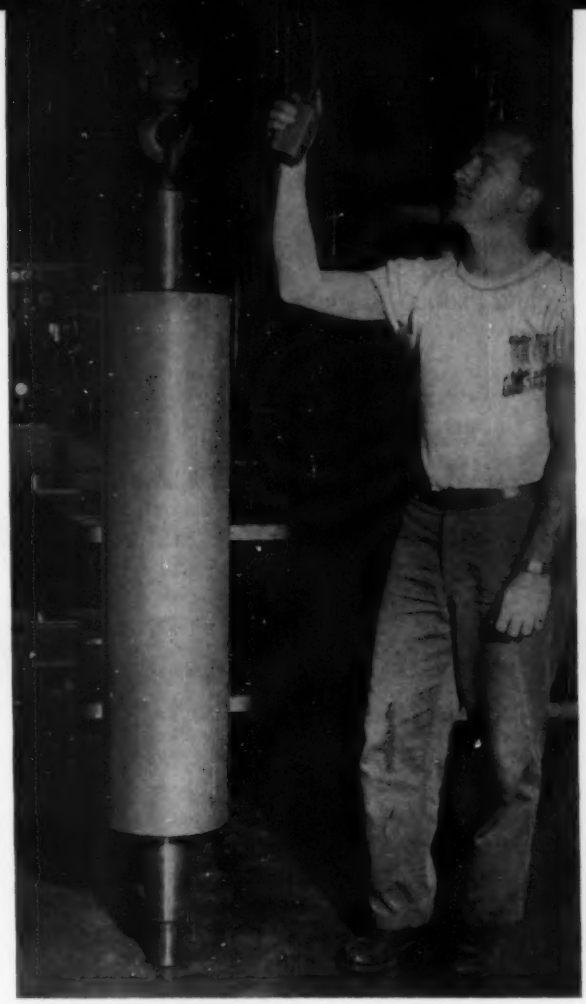
low-cost

offers: good frictional characteristics without lubrication, non-galling to mating surfaces, resistance to corrosion by alkali solvents and mild acids, resilience, light weight, and good electrical insulation properties. It then becomes clear that the material is in a good position to offer a serious challenge to many of the cast metals now used in machine parts.

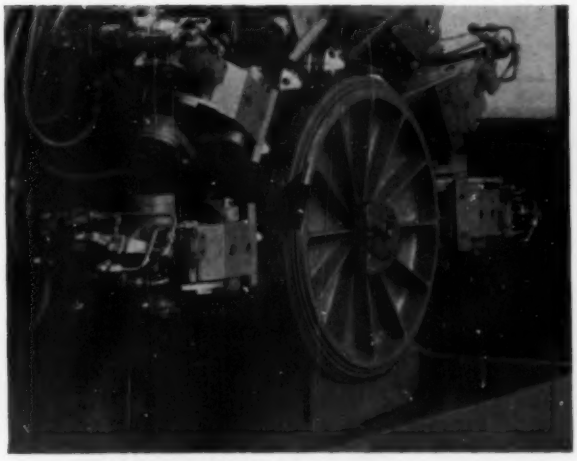
There are, of course, limitations: Monomer-cast nylon is severely attacked by strong acids. It is considerably less rigid than metals. It is limited to temperatures of 250 to 300° F. on prolonged exposure. And, in terms of tensile strength, metals are 2 to 10 times stronger than nylon. Sometimes the advantages of nylon and metal can be combined by using both materials, as in the leather-processing roll shown at right. It is used by the Eberle Tanning Co., Westfield, Pa., to orient hide in the manufacture of shoe leather. Here, monomer was cast around an 800-lb. steel roll to combine the frictional advantages of nylon with the strength characteristics of steel.

Here are the markets

Bushings and bearings. Nylon has long proved itself in this field in small parts. Monomer-cast materials now bring **(To page 168)**



LOAD-BEARING PROPERTIES of nylon are combined with the strength properties of steel in this leather processing roll, made by casting caprolactam nylon monomer around an 800-lb. steel shaft. Monomer casting provides one-piece construction, eliminating costly boring and fitting of separate machined cover.



GEAR-HOBBING MACHINE made by Cleveland Hobbing Machine Co. has large-diameter gear of monomer-cast nylon (shown by arrow) which drives a number of smaller gears in an abrasive slurry process for cutting metal gears. This application takes advantage of the frictional and resiliency properties of the material to assure optimum operation of the machine.

Monomer-cast nylon vs. foundry metals

(custom casting, 158 cu. in.)

Material	Weight	Price/lb.	Unit price	Price, cu. in.
	lb.	$	$	$
Stainless steel (304)	46	1.18	54.28	34.4
Extrusion-molded nylon	6.5	6.70	43.70	27.7
Bronze	51	0.68	34.65	21.9
Yellow brass	48	0.64	30.60	19.4
MC nylon (present)	6.6	3.32	21.91	13.9
Mild carbon steel	46	0.32	14.72	9.3
MC nylon (projected)	6.6	2.00	13.20	8.4
Aluminum 40-E	14.5	0.87	12.60	8.0
Aluminum A-108	14.5	0.76	11.00	7.0
Cast iron	42	0.195	8.19	5.2

Prices based on actual present quotations on 1000-piece lots of rough casting with tolerances of +1/32 in. and —0. Pattern costs and subsequent machining costs are not included. For many uses, nylon does not require the expensive finishing necessary with metals. **Note:** All prices listed must be considered as a guide to comparative costs only.

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SPECIAL DECORATIVE EFFECTS

By Hal-Curtis Felsher*
and Walter J. Hanau*

The ease and variety of ways in which plastic articles may be decorated has played a major part in the phenomenal growth of the industry. Many of the industries using plastics are highly competitive, and the achievement of new effects is of utmost importance in maintaining competitive position. This article reviews possible methods by which these effects can be extended, and analyzes the basic visual causes of the more complex decorative effects.

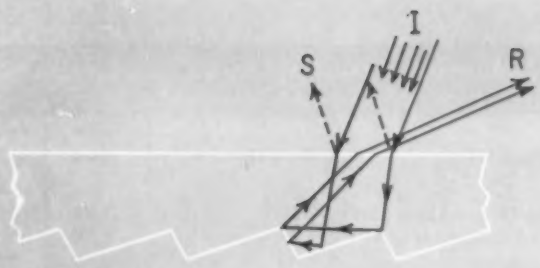
There are, of course, two basic methods for coloring plastics: 1) surface decoration through the use of printing, spraying, dipping, etc., and 2) integral coloring, in which the coloring matter is contained within the plastic mass itself. There are, also, hybrid methods which fall between these two techniques, (*e.g.*, vinyl plastisols, polyester gel coats, or color film laminations).

Special pigments

In order to understand decorative possibilities, it is important to know the manner in which various coloring materials used in plastics affect the behavior of light.

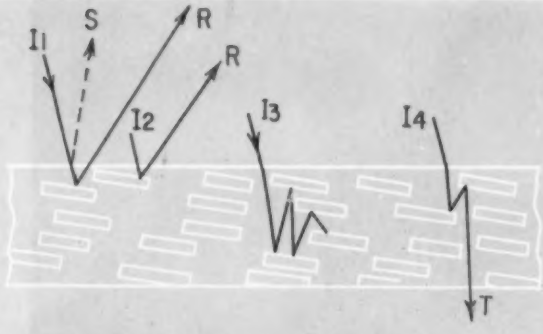
The term "conventional color effects" refers to those which are obtained by selective absorption and reflection of light of various wave lengths by pigments incorporated into a plastic article or coating. These pigments, which are most familiar

*Respectively, Dir. Research & Development and Chief Chemist, Claremont Pigment Dispersion Corp., Roslyn Heights, N. Y.



REFLECTIVE REVERSE EMBOSSING

FIG. 1: Incident light beam (I) enters smooth or slightly wavy top surface, except for small amount reflected (S). Main portion of light hitting embossed bottom surface of sheet is totally reflected twice, and is seen as a very bright reflection (R) at certain angles of viewing.



ORIENTED METALLIC FLAKES

FIG. 2: Incident light, represented here by four rays (I) enters top surface except for a small amount of surface reflection (S—shown only for ray I_1). Most of light rays I_1 and I_2 is reflected back at specular angle (R); some light (I_3) is trapped behind flakes and gradually absorbed upon multiple reflection; and some (I_4) finds its way through interstices between flakes and passes out through bottom surface.

to molders, range from white—through colors of varying hue, value, and saturation—to black.

When one gets in the area of "special color effects," pigments are available which can produce unusual brightness and striking effects. For example, there are the daylight fluorescents which, instead of absorbing unwanted wave lengths of light, convert unwanted wave lengths into light of desired wave lengths. As a result, these colors seem to possess an actual glow of their own. Luminescent pigments are also available to produce striking effects in the dark. There are basically two types. One type is activated by ultra-violet illumination, producing very strong luminescence and, consequently, very eye-catching effects. The other type, known as phosphorescent pigments, does not require any separate source of illumination; however, the time of strong after-glow in most cases is quite limited, as is the choice of luminescent colors, which generally ranges from blue to orange.

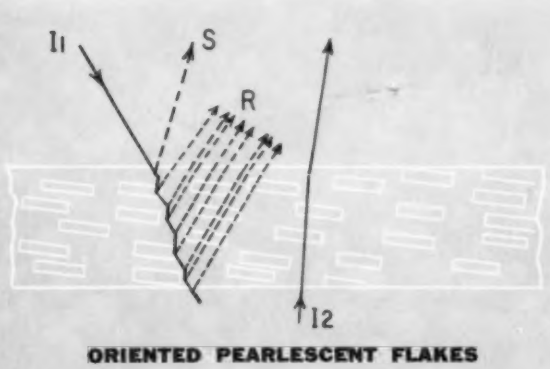
Activation of luminescent materials by inclusion of a radioactive component is well known but does not seem to hold any promise for widespread decorative use because of the obvious hazards of this type of material. However, definite decorative applications can be foreseen for another type of application in which a phosphor is activated by direct application of comparatively high voltages across the phosphor layer on the plastic (*i.e.*, electroluminescence).

In all of the aforementioned examples, the color stimulus which the eye receives from any particular area is devoid of any feeling of depth or structure; they do not really take full advantage of the variety of unique properties of plastics materials.

Three dimensional effects

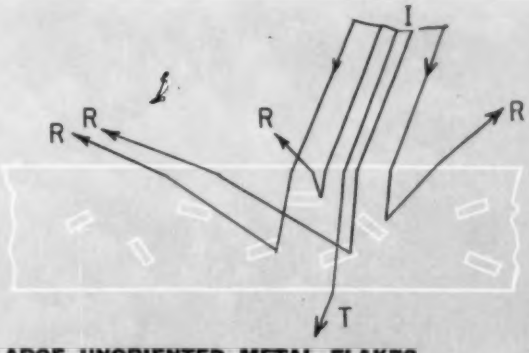
By their nature plastics lend themselves to design possibilities which cannot be reproduced by any other class of materials. By taking advantage of plastic's transparency and formability, articles can be given an appearance of depth in an infinite number of variations. In its simplest form, this is provided by a transparent overlay—either with or without the use of a transparent pigment or dye. A modification of this idea is the printing or spray painting of the back of a transparent plastic article so that in the final effect the color is seen through the transparent plastic.

As far as integral coloring is concerned, one technique used is the incomplete mixing of plastic masses of different colors. In order to provide more than a surface effect, some of these masses must be transparent or, at least, highly translucent. For best contrast effect the remaining colors should be highly opaque. Examples of techniques which assure this incomplete mixing or non-mixing are: 1) compression molding a mass consisting of chunks or pieces of varied colored material; 2) injection molding or extrusion with insufficient mixing; 3) introduction of pieces of a contrasting color into a calendering mass which will produce either a marble effect or one of distinct inclusions depending on the size and temperature of the contrasting pieces, temperature of the calendering mass and place of introduction. **(To page 177)**



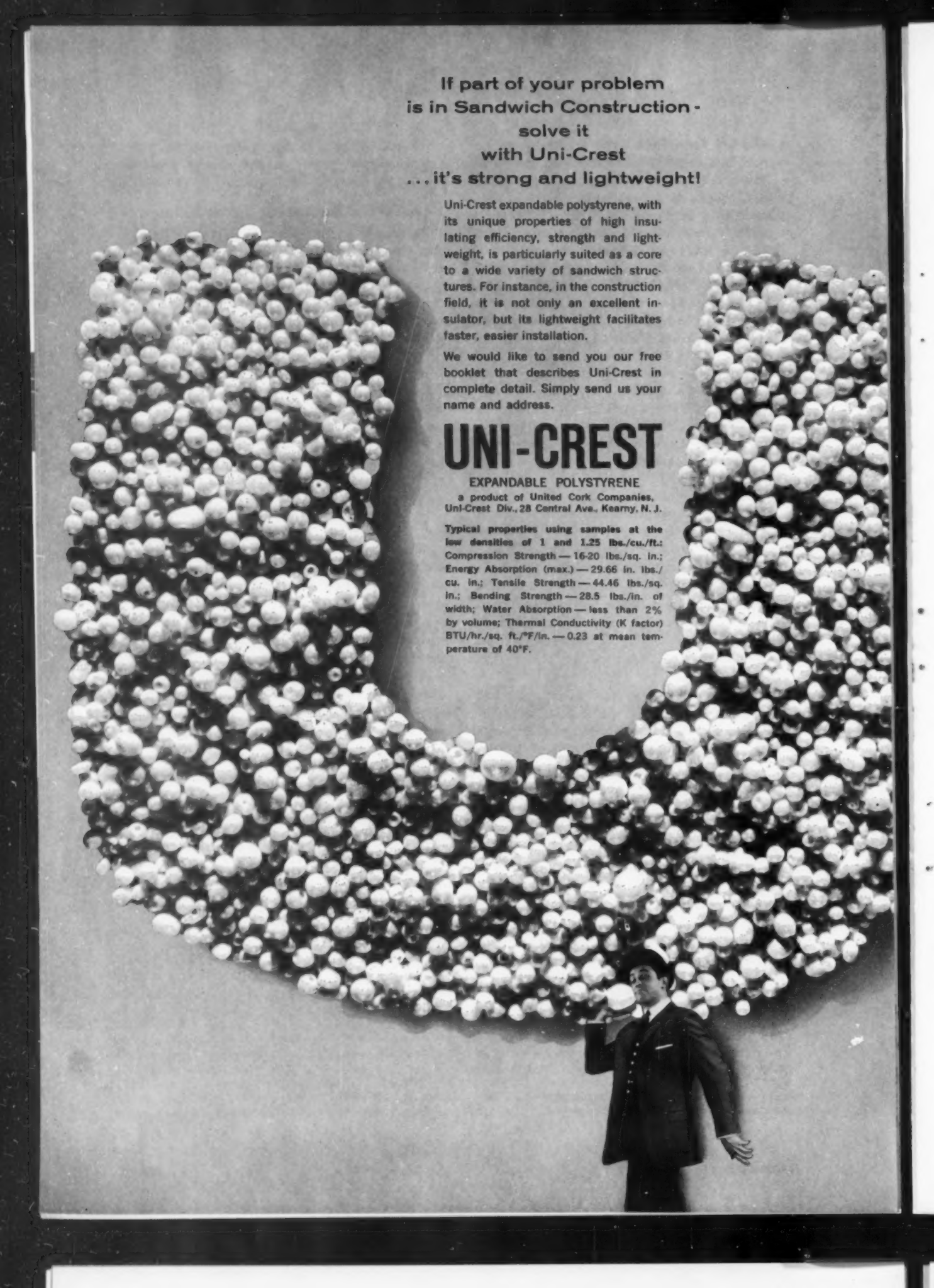
ORIENTED PEARLESCENT FLAKES

FIG 3: Incident light (I_1) enters top surface, except for some surface reflection (S). Wherever the rays meet a transparent flake, part is reflected (R) from both surfaces of the flake and part passes through. Similarly light (I_2) is observed along with reflections (R). This illustrates diffuse brilliance and translucence.



LARGE UNORIENTED METAL FLAKES

FIG. 4: A beam of light, shown here by five rays (I), enters top surface. It is reflected (R) in random directions by the unoriented flakes, and shows up as brilliant points of light shifting as the light source or the observer moves. Part of light (T) passes through sheet between flakes. Flakes must be large enough to produce individual reflections of sufficient intensity.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George R. Smoluk, ENGINEERING EDITOR

PLASTICS ENGINEERING*

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How to make coatings stick to acetal resin

Chemical surface treatment produces excellent adhesion of paints and bonding compounds to acetal surfaces without use of primers

By Walter M. Bruner† and Carlos M. Baranano†

A new and economical surface treatment for Delrin acetal resin, called Satinizing[1], now makes possible superior bonding and coating of molded parts. The process involves exposure of the resin surface to a chemical formulation which renders the thermoplastic unusually receptive to both paints and adhesives. By this process many consumer products may now receive better painted or metallized finishes at lower cost; many may be joined more firmly because of the improved bond strengths of adhesive joints. Although the treatment discussed here is specific to Delrin acetal resins, a number of other plastics can be similarly treated with other suitable treating formulations in order for them to achieve like surface effects.

The treatment is accomplished very quickly under mild conditions. And moldings of exceedingly complex geometry may be treated as readily as simple forms. The process may be used with small equipment for treating a few parts or with automated systems for large quantities. Furthermore, the treating formulation consists of readily available materials—in contrast with the concentrated acids or bases often used in metal prefinishing processes, the chemically active treating agent is effective at a concentration of only a few tenths of 1% in the formulation.

General principles of the process

The surface treatment consists basically of etching or chemically roughening the surface of the acetal part. This creates mechanical anchor points for coatings and adhesives uniformly distributed over the entire surface of the part. These positive anchor points firmly bond the finish or adhesive to the surface. The bond strength is not dependent on intermolecular attrac-

*Reg. U. S. Pat. Off.
†Polychemicals Dept., Du Pont, Wilmington, Del.
[1]Satinizing is the descriptive title adopted by Du Pont for its prefinish process on which a patent is now pending.

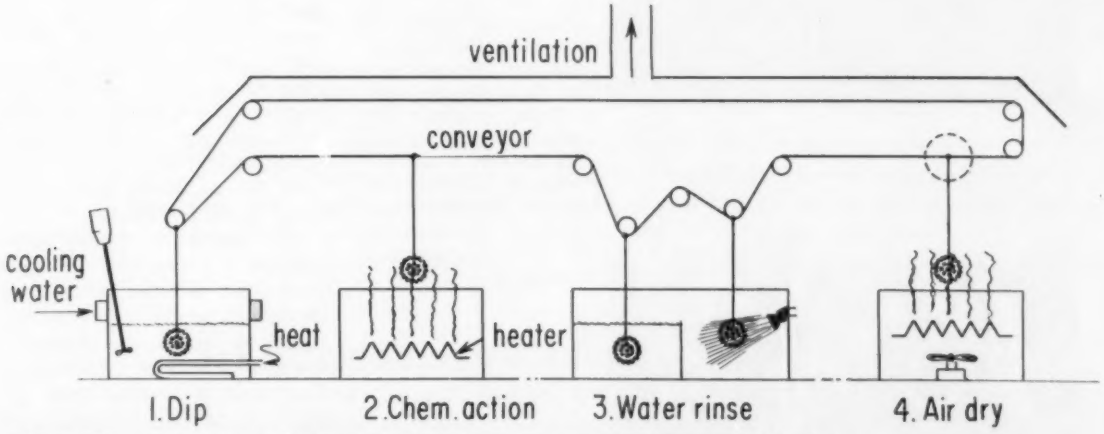

FIG. 1: Schematic drawing of the chemical surface treatment process for acetal resins showing how it could be adapted for the continuous production of molded parts.

tion between the resin surface and the finish or adhesive.

For many thermoplastics, intermolecular surface forces are exceedingly weak, resulting in poor adhesion. Since Satinizing does not depend on the chemical nature of the coating or adhesive, a wide choice of finishes (paint, lacquer, or enamel) may be used *without* primer. The process also permits the use of a wide range of adhesives and metallized finishes. Coating adhesion and bond strength exceed those obtained in the past through solvent-cementings, flaming, or special paint priming.

Surfaces prepared by chemical treatment perform better than those roughened by either dry or wet mechanical abrasion methods. The roughening which mechanical methods provide is highly directional; it varies in quality; and it is difficult to apply successfully on intricate objects. Chemical treatment gives sharper anchor points and is uniformly effective on all contours. Moreover, Satinizing is usually less costly, requiring less labor and less complex equipment.

The surface treatment is accomplished by intimately wetting articles with a formulation having a chemically reactive agent and a small amount of finely divided, inert, solid particles, dispersed in a liquid vehicle. The small proportion of dispersed and finely divided solids serves the important function of distributing the treatment uniformly over the surface of the part.

An important feature of the process is the precise control which it offers. Quality and extent of treatment are achieved by conducting the major part of the chemical action in warm dry air. Effective action occurs when the solvent, or liquid vehicle, has evaporated—leaving the solid particles, and the active agent with them, uniformly distributed over the surface being treated. Contrary to reaction in the liquid phase, chemical action in air provides sharp anchor points through the action of only a trace of chemical agent. The surface reaction is stopped at the desired point by quenching the article being treated in water.

By use of this method, every portion of the surface area is treated to substantially the same extent without altering the hardness and abrasion resistance of the original surface. Various degrees of surface roughness can be obtained, ranging in appearance from "satin smooth" to "well-frosted." The profile of treated areas viewed microscopically shows a large number of sharp jagged peaks and crevices which provide for strong mechanical adhesive bonds. Other treatments, *e.g.*, mechanical abrasion, chemical washes, or flaming, fail to provide a similarly sharp or uniformly distributed surface irregularity in comparison.

Table I: Corrosion rates[a] of various metals in Satinizing surface treatment formulation[b] at 250° F.

Metal	*Corrosion rate in./month*
Stainless steel (Type 316)	0.000053
Stainless steel (Type 304)	0.0002
Galvanized steel	0.00035
Aluminum	0.001

[a]Corrosion rate or inches per month penetration is equal to 43.9 times the weight loss (g.) divided by the product of the area (sq. in.), density (g./cc.), and the time of exposure in hours. [b]Treating agent formula by weight: 0.8% p-toluenesulfonic acid, 1.2% diatomaceous earth, 5% dioxane, and 93% Perclene (Du Pont brand of perchloroethylene).

FIG. 2: Two photomicrographs showing the control over acetal resin surface roughness obtainable using the chemical treatment. The upper picture shows a surface with a 20-μin. roughness; the lower picture, a surface with a 60-μin. roughness. Ordinarily, for good coating adhesion, the surface roughness should exceed the 20-μin. roughness that is shown above.

The treating composition

The treating formulation is a dispersion with three principal ingredients: 1) a chemically active agent, 2) a liquid vehicle and 3) dispersed solid particles. Other ingredients, of course, can be added in order to assist the treating action —for example, a surface-tension depressant and an additive to solubilize the chemically active agent in the liquid vehicle.

The chemically reactive agent, normally a proton donor, initiates controllable polymer cleavage, or dissolution, in the surface layers. It may be present as a dispersion, emulsion, or solution in the vehicle. The preferred reactive agent for Delrin acetal resin is p-toluenesulfonic acid.

The function of the liquid ve-

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hicle is to dissolve the reactive agent and to disperse the solid particles. The properties of the vehicle chosen control the formulation's ability to wet the plastic surface. If the inherent wetting capacity of the vehicle is deficient, wetting agents may be added. The vehicle should evaporate easily for fast removal from the plastic surface. Non-flammability is desired for safety reasons, but it is not essential for processing. Examples of vehicles are chlorinated hydrocarbons, ethers, esters, ketones, alcohols, and water in combination with one of the suitable surface-tension depressants.

Contamination of the formulation by silicone oils or greases should be avoided, although traces of hydrocarbon oils do not diminish operability. When used as the vehicle, chlorinated solvents mildly degrease the treated article. The preferred vehicle in the formulation for Delrin is perchloroethylene.

The dispersed solid particles serve only as a carrier to distribute chemical action and to improve its uniformity. They must be insoluble in, and inert to, the treating medium. They must be in the form of fine particles to facilitate dispersion and distribution on the plastic article. Especially desirable solids include the diatomaceous earths, materials of high silica content (*e.g.*, quartz and various clays—attapulgite, kaolinite, and bentonite). Formula activity may be checked periodically by titration or by paint adhesion tests on the treated article.

The process

The surface treatment consists of four steps (diagrammed in Fig. 1, p. 97), after which the article is ready for painting, assembly, or other finishing operation. These steps are noncritical, since time and temperature may be varied considerably to obtain desired effects and to suit facilities on hand. Conditions given in the steps described below are typical of those suitable for Delrin acetal resins.

1—Dip. The article is immersed in the treating formulation at 175 to 250° F. for 10 to 30 seconds. The entire surface is contacted and chemical reaction begins. Temperatures above this range may give too rapid an action and **(To page 104)**

Table II: Correlation of treated Delrin acetal resin surface roughness with treating conditions[a]

Step 1 — Dip time[b]	Step 2 — Chemical action	Roughness range
sec.	*sec.*	*μin.*
5	60	14 to 17
10	60	17 to 23
20	60	28 to 34
30	60	36 to 42
30	80	44 to 52
30	100	46 to 54

[a]Step 1 treating formulation temperature was 212° F. Step 2 air temperature was 250° F. [b]Treating agent formula by weight: 0.25% p-toluenesulfonic acid, 0.5% Dicalite bulk aid (Great Lakes Carbon Corp.), 2.75% dioxane, and 96.5% Perclene.

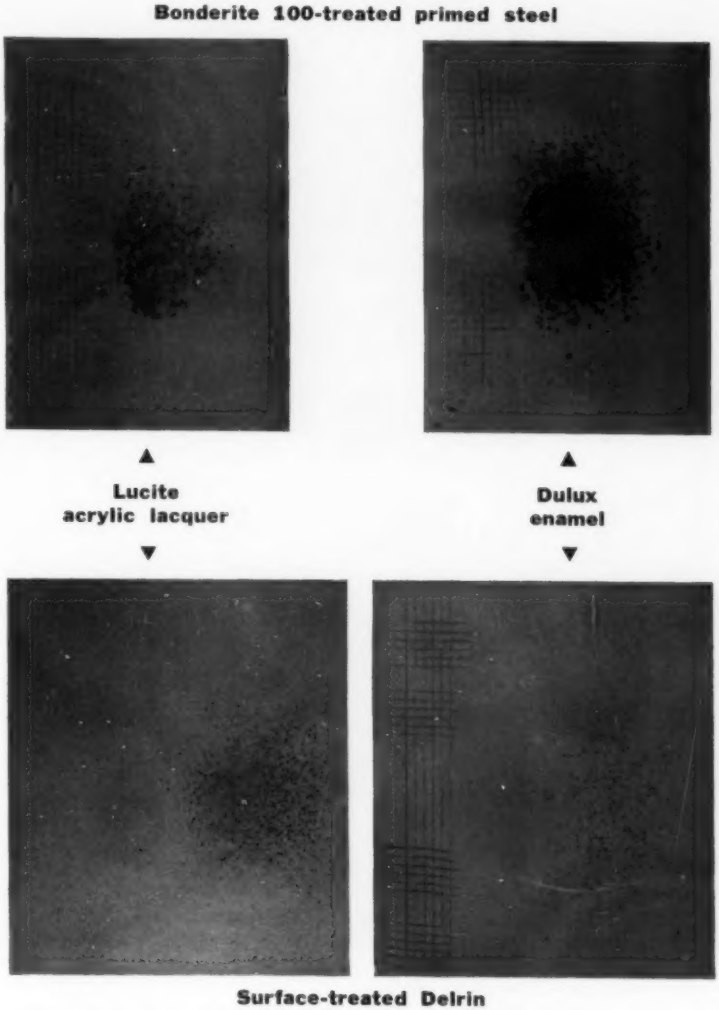

FIG. 3: Photographs comparing the adhesion of an acrylic lacquer and an enamel paint (both used as automotive finishes) to 1) steel treated with Bonderite 100 primer prior to the application of the lacquer or enamel, and 2) Delrin with its surface treated as described in this article. No primer or other treatment was used. This test was conducted by impacting gravel-size Alundum abrasive on both of the painted surfaces. Note the greater amount of erosion of the paints on the steel surfaces.

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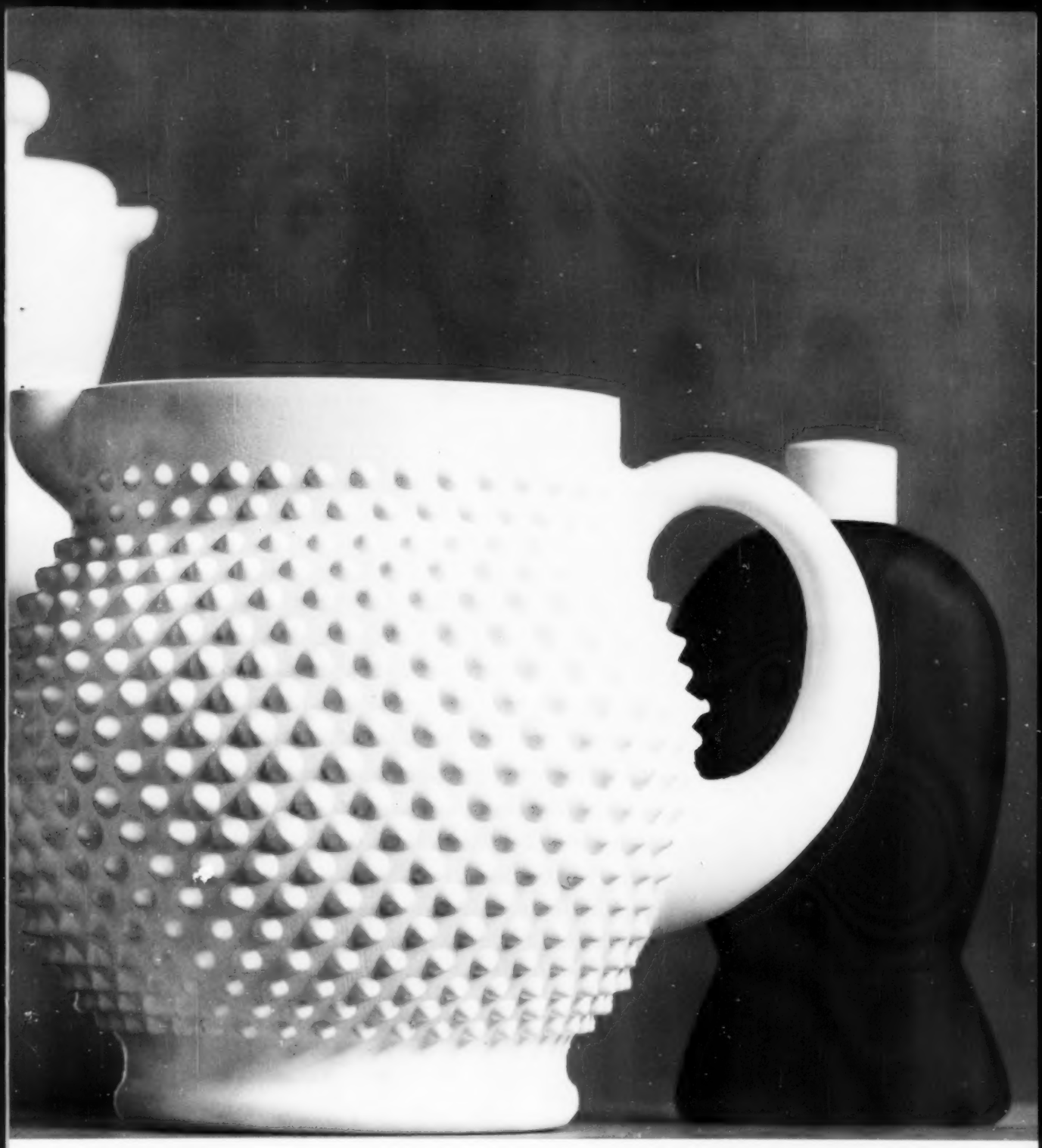

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Table III: Correlation of treated Delrin acetal resin surface roughness with treating conditions showing effects of increased dip temperature and increased chemical action time[a]

Step 1 — Dip		Step 2 — Chemical action		Roughness range
Time	Temp.[b]	Time	Temp.[c]	
sec.	°F.	sec.	°F.	μin.
30	212	60	250	48 to 54[d]
30	250	60	250	54 to 58
30	250	120	250	115 to 125

[a]Treating agent formula by weight: 0.3% p-toluenesulfonic acid, 0.5% Dicalite, bulk aid, 3% dioxane, 96.2% Perclene. [b]Temperature of treating agent. [c]Air temperature. [d]Compare these values obtained at 0.3% p-toluenesulfonic acid with those obtained at comparable processing conditions in Table I using 0.25% p-toluenesulfonic acid.

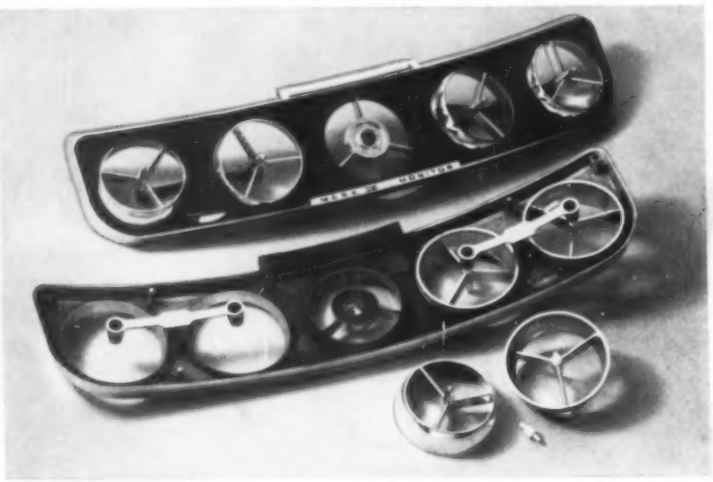

FIG. 4: Delrin acetal resin face plate assembly for Mitchell auto air conditioner. Decorating paint and metallized finish durability were enhanced by using the Du Pont Satinizing process.

possibly increase vehicle evaporation losses. At about 100° F., chemical action is too slow for effective treatment. Good agitation is important to suspend the inert solid particles and uniformly distribute them on the treated article.

The article should touch nothing except the device by which it is held. At the end of the immersion cycle the article is removed from the dip tank and passed to Step 2.

2—Chemical action. Most of the chemical action occurs while the article is exposed to air at 100 to 250° F. for about 60 seconds. Entrained vehicle or solvent evaporates rapidly at the beginning of this step. Degree and quality of treatment are easily controlled by exposure time and air temperature. Adequate ventilation is needed for Steps 1, 2, and 3, and is discussed further under "Equipment."

3—Water rinse. This stops the treating action and flushes solid particles from the surface. Although cold water may be used, water at 160 to 175° F. is more efficient. A convenient procedure is to dip the treated article momentarily in water and then rinse with a hot-water spray. For finishes requiring dust- or particle-free surfaces, such as vacuum-metallized finishes, it is preferable that all the inert solid particles be completely removed from the surface. However, for routine painting, all traces need not be removed.

4—Air drying. The drying rate

Table IV: Comparative performance of Satinized Delrin *vs.* Bonderite 100-treated steel

Primer	Initial primer adhesion	Topcoat	Init. tape adh.	Init. knife adh.	Oven aging 200° F. for 180 hr.		Cold crack 2 cycles			48-hr. humidity cabinet		
					Tape adh.	Knife adh.	Blist.	Tape adh.	Knife adh.	Blist.	Tape adh.	Knife adh.
Satinized Delrin												
None		878-94908	10	10	10	10	OK	10	10	OK	10	10
None		877-94783	10	10	10	10	OK	10	10	OK	10	10
None		170-77704	10	8	10	10	OK	10	10	OK	10	9
None		G-799-22562	10	10	10	9				OK	9	9
Bonderite 100-treated steel												
828-1946	10/10	878-94908	10/10	9/7	10/10	10/10	OK	5/5	4/6	OK	6/6	5/6
828-1946	10/10	878-94783	10/10	10/10	10/10	10/10	OK	5/5	7/10	OK	5/5	9/9
828-1946	10/10	G-799-22562	10/10	9/9	10/10	10/10				OK	10/8	9/10
None		877-94783	2	0	7/7	0/0	OK	1/1	1/1	OK	5/4	0/0

Key: 828-1946—Light gray corrosion resistant primer; 878-94908—Light blue interior automotive Lucite acrylic lacquer; 877-94783—Dark green metallic interior automotive Lucite acrylic lacquer; 170-77704—White baking enamel; G-799-22562—Silver metallic interior Dulux baking enamel; 10 = Excellent, 6 = Good, 0 = Very poor; 10/10 = the symbol/separates 2 samples, one with a primer film thickness of 0.7 mils/the other 1.2 mils thick. In the single case where no primer was used (877-94783), the slash-mark separates two samples, one with a topcoat thickness of 0.7 mils; the other, 1.2 mils thick.

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is not critical and may be adjusted to suit the production schedule. After drying, the article is ready for the immediate application of finishes, assembly with adhesives, or storage. The latter has no effect on the treatment.

Equipment

Any molded article can be treated batchwise with the following units:

1. A dip tank (of suitable size to handle the parts to be treated) to contain the treating formulation. It should be equipped with steam or electric heaters, stirrer, and vapor reflux condensing coils.

2. A hot-air chamber to expose articles to heated air while the chemical action occurs.

3. A pan with sewer drains for a water-immersion rinse, or a spray-rinsing system, or both.

4. A rack or table for air-drying at room temperature or a hot-air oven for rapid drying.

5. Suction-type ventilation equipment to remove traces of the vehicle and other volatiles released in treatment.

Materials of construction depend on the choice and concentration of formulation ingredients. For units designed to treat Delrin parts, stainless steel dip tanks are recommended. Table I, p. 98, gives corrosion rates for several metals that were exposed to a typical treating composition.

Adequate ventilation is required to carry off non-condensed vehicle and other vapors. For example, in treating acetal resin, formaldehyde may be released in Steps 1 and 2 described above. Ventilation should keep the atmospheric-formaldehyde concentration below 5 ppm.[2] For good ventilation without excessive vehicle loss, the dip tank can have a lip vent around the edges where air is exhausted at about 60 linear ft. per minute. In the chemical action step, **(To page 185)**

[2] "Threshold Limit Values for 1961," adopted at the 23rd Annual Meeting of the American Conference of Governmental Industrial Hygienists, Detroit, Mich., April 9-12, 1961, reported in the American Industrial Hygiene Journal 22, No. 4, 325 (1961).

Table V: Comparison of typical average values of the mechanical properties of treated and untreated Delrin acetal resin

Property[a]	*Treated*[b]	*Untreated*
Tensile modulus, p.s.i.	515,000	523,000
Ultimate tensile strength, p.s.i.	10,200	10,300
Ultimate elongation, %	31	36
Izod impact strength, ft. lb./in. notch	1.04	1.02

[a] Measurements made 8 weeks after treatment using ASTM test methods. [b] Treating agent formula by weight: 0.9% p-toluenesulfonic acid, 2.4% Attapulgus clay, 5.7% dioxane, and 91% Perclene.

Table VI: Examples of treatments given to acetal and nylon resin surfaces to develop optimum surface characteristics for various coating and adhesive bonding applications

EXAMPLE:	**1**	**2**	**3**	**4**	**5**
Treating formulation (% by weight)					
Active agents					
p-Toluenesulfonic acid	0.3	0.3	0.3	0.9	—
Phosphoric acid	—	—	—	—	10.0
Finely divided inert solids					
Dicalite bulk aid[a]	1.0	0.5	—	—	0.5
Cab-O-Sil[b]	—	—	0.13	—	—
Diatomaceous earth	—	—	—	2.0	—
Quartz	—	—	—	2.0	—
Solvent and vehicle					
Perclene	95.7	96.2	96.57	—	—
Tap water	—	—	—	95.0	89.4
Solubility assistants					
Dioxane	3.0	3.0	3.0	—	—
Triton X-100[c]	—	—	—	0.1	0.1
Processing conditions					
Step 1, Dip					
Time, sec.	30	5	10	60	60
Temperature, °F.[d]	194	212	250	194	203
Step 2, Chemical action					
Time, sec.	60	30	20	60	60
Temperature, °F.[e]	250	250	250	250	250
Results					
Degree of surface roughness, μin.					
Delrin acetal resin	55 to 57	38 to 46	24 to 42	75 to 80	110 to 140
Zytel nylon resin	—	28 to 32	—	—	14 to 20
Glossmeter reading					
Delrin acetal resin	2	3	—	1.5	—
Zytel nylon resin	—	27	—	—	—

[a] Particulate solid made by Great Lakes Carbon Corp. [b] Particulate solid made by Godfrey L. Cabot Inc. [c] Surface tension depressant made by Rohm & Haas Co. [d] Temperature of the formulation. [e] Temperature of hot air used in action step of process.

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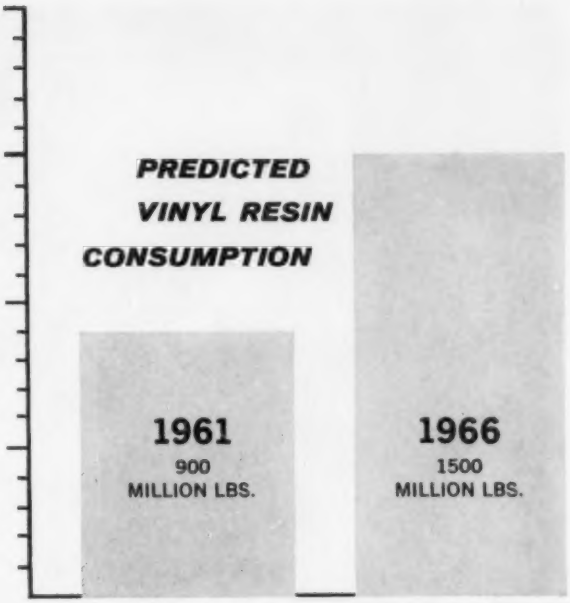

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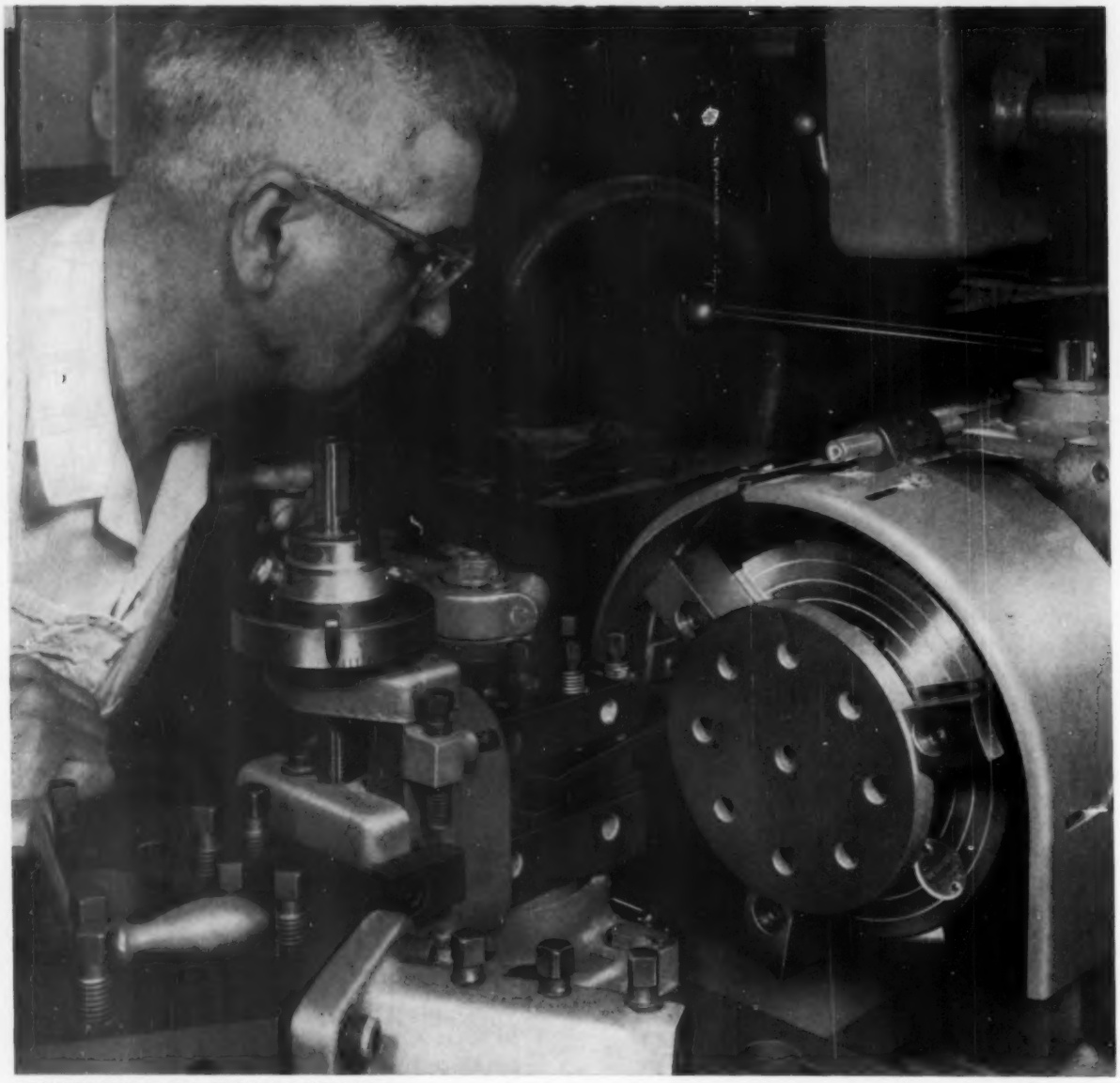

ENGINEERING ECONOMICS—There were a number of problems involved in the making of this electrical terminal plate for a refrigeration compressor unit. The need for the terminal plate to hermetically seal the compressor refrigerant meant that the outside dimensions of the plate and the terminal mounting holes had to be machined to extremely rigid tolerances. In addition, the application required high tensile and impact strength, resistance to chemical attack, and high dielectric strength. Through its experience in making phenolic laminates, Spaulding Fibre Company, who also fabricated these precision terminal plates, was able to suggest changes in specifications which met every one of the stringent requirements, and yet resulted in real savings for their customer. The laminates utilized in making these terminal plates were made from Mount Vernon Duck.

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Hi-Fi textures for plastics

Cold-setting polysulfide rubber with negligible shrinkage is key to duplicating wood grain and other natural surfaces in plastics molds

By J. H. Tompkins* and K. R. Smith†

Most natural surfaces can now be so faithfully reproduced in plastics that only touch discloses that a product is not wood, marble, stone, wax, plaster, metal, or glass.

Vinyl-supported fabrics, flooring, table accessories, upholstery, handbags, and shoes are among a wide range of products made with finishes that the eye alone cannot distinguish from the master material.

A method of mass reproduction of natural surfaces for use in processes such as compression molding, injection molding, embossing, and vacuum forming has been developed by a firm specializing in basic research in electroform tooling.

The method involves duplication of a natural surface in cold-setting polysulfide rubber and then transfer of the rubber duplicate onto rollers or dies by the electroforming process. Fig. 1, right, shows the four basic stages of the process. This technique has been made possible by two outstanding properties of cold-setting rubber: absence of shrinkage and ability to withstand corrosive chemicals used in an electroplating bath.

The new surface-duplicating method is a development of Electroform Corp., a wholly-owned research subsidiary of L. E. Carpenter & Co. The rubber material used in the method was developed by Smooth-On Manufacturing Co., and is based on FMC No. 200 (Black) Flexible Mold compound.

Recently, Electroform Corp. was given the problem of devising a method of reproducing in plastic not only the appearance of rough natural surfaces such as wood or stone, but also of recreating the actual surface features, holes, ridges, and all. Through work on this problem, the company discovered the suitability of cold-setting polysulfide rubber compounds for electroform tooling.

For years the usual method of attempting a job like this had been a difficult and time-consuming process, with uncertain results. First an impression had to be made in artist's clay. Then successive layers of sprayed latex reinforced with cheese cloth had to be added to obtain a flexible mold. But since latex has considerable shrinkage, exact duplication of the texture that was being reproduced was seldom possible.

Reproducing not only the look but also the "topography" of rough surfaces required a material with simpler and faster curing properties. At the same time, minimum shrinkage for absolutely faithful reproduction of detail was essential. Electroform Corp. experimented with polysulfide rubber compounds as a possible answer. These materials cure overnight and are ready for electroforming 24 hr. after pouring. Moreover, they were found to reproduce natural rough surfaces accurately. As a result of their performance in this application, Electroform based its new process on the FMC compounds.

The surface reproduction process is perhaps best described by a step-by-step explanation of how tooling was developed to give a line of home furnishings the appearance of being made of fine-grained, polished wood. But almost any natural surface can be reproduced by the same process. The manufacturer of the "wood-like" product line first selected a piece of wood having the desired **(To page 112)**

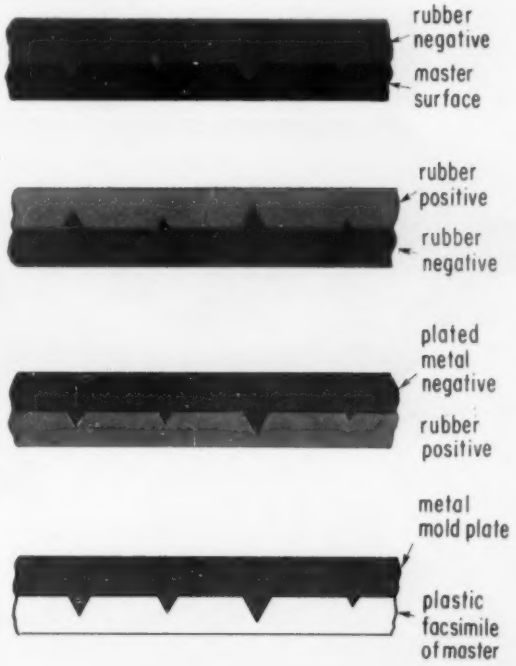
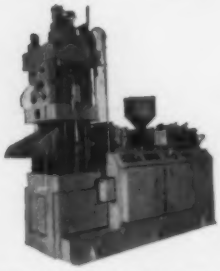


FIG. 1: Steps and materials stages that are involved in making negative nickel mold plate of wood-grain surface. Any natural surface can be faithfully reproduced using this novel method.

*Technical Dir., Smooth-On Mfg. Co., Jersey City, N. J.
†Chief Engineer, Electroform Corp., S. Norwalk, Conn.



New Model 706 12-ounce Automatic Injection Molding Press with screw plasticizer.

The new Stokes Model 706 12-ounce Press offers all the proven advantages of truly automatic injection molding with the added features of a newly designed screw plasticizer.

The Stokes-developed plasticizer, combined with proven nozzle shutoff and pressure prepack, speeds production of strain-free parts. The new Model 706 press *plasticizes, molds, de-gates, ejects and sorts automatically*. Even the sprues and runners are channelled into separate bins.

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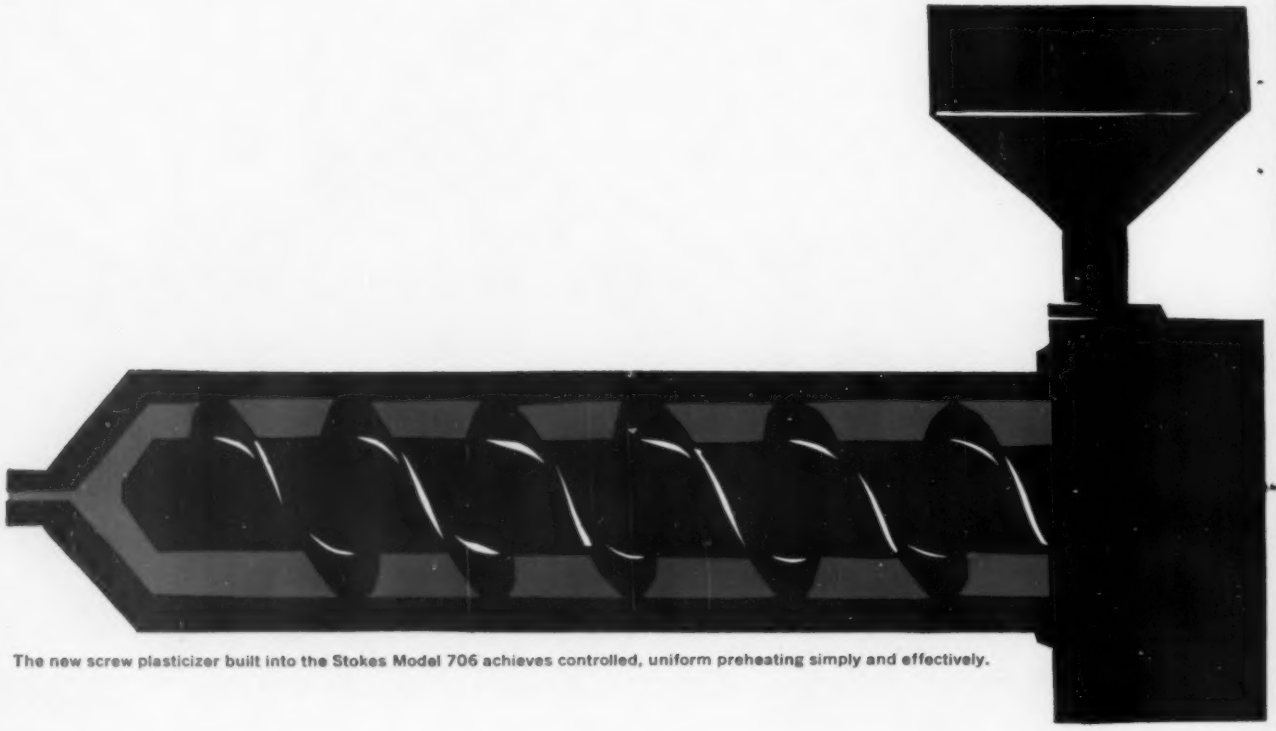

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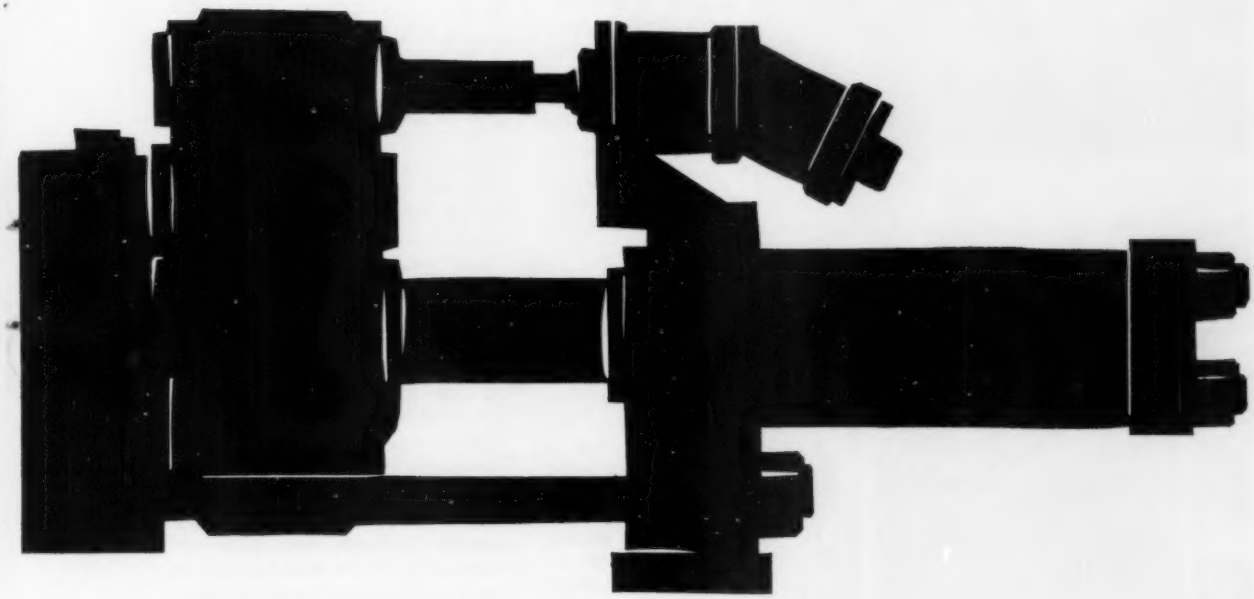
WITH SCREW PLASTICIZING



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texture and surface. This piece of wood became the master model. Then, the texture of this specimen was reproduced in this way:

1. Wood surface was coated with Smooth-On's Sonite release.

2. A "dam" was built around the wood master with masking tape. The dam was built high enough to contain the thickness of the polysulfide rubber casting.

3. A black polysulfide rubber compound was thoroughly mixed and then poured over the wood as shown in Fig. 2, below. It was carefully brushed over the surface to insure intimate contact of the compound with the wood and to eliminate air entrapment. In addition, the table, or working surface, on which the master impression is prepared is made flat to avoid danger of a misshapen final mold.

4. After pouring, the rubber was allowed to cure. Curing normally requires anywhere from 12 to 18 hr., depending on ambient temperatures. It can be speeded up by heating. However, when curing at room temperature, a casting poured in the afternoon can be handled the next morning.

FIG. 2: Catalyzed cold-setting polysulfide rubber compound is poured over wood-grain master.

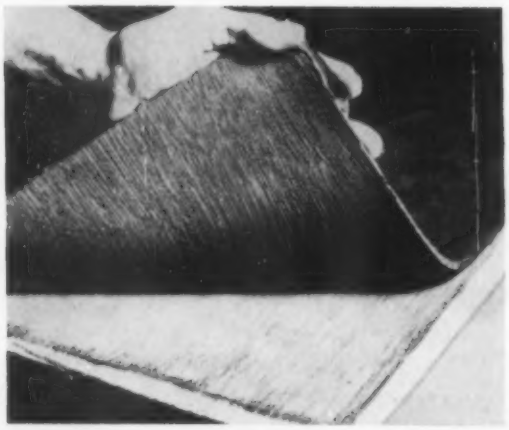


FIG. 3: Photograph showing how rubber negative of wood-grained surface has faithfully reproduced the wood master.

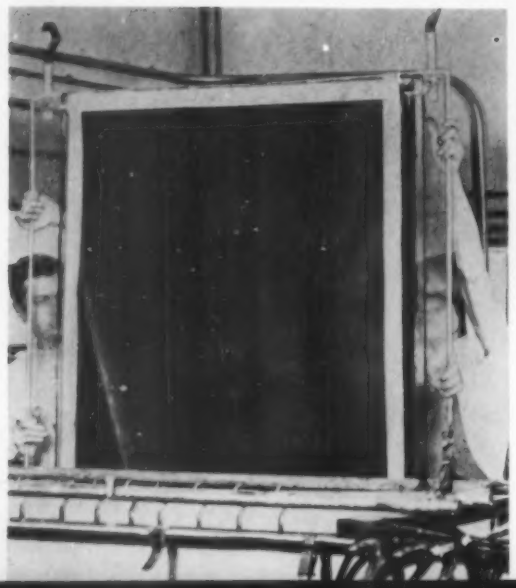


FIG. 4: After the rubber positive has been treated with a conductive coating and mounted on an acrylic sheet, it is placed in the electroforming bath for deposition of the nickel negative that is to be used in forming the plastic surface.

5. Next the rubber casting was separated from the original wooden master (See Fig. 3, left). This gave a negative impression of the surface to be reproduced. Since a positive in rubber is needed to obtain a negative in metal, a second casting to produce a negative of the rubber negative (a rubber positive of the original wood surface) was required. Therefore, the original casting process was repeated using the first casting.

6. When the second casting was completed and then cured, the rubber positive was removed from the original rubber negative; it was, of course, an exact rubber replica of the original piece of wood.

7. This rubber positive was then mounted on an acrylic sheet, using double-faced adhesive tape. Silver was then chemically precipitated onto the rubber surface to provide electrical conductivity.

8. The rubber mold, with the thin silver coating was then immersed in a Barrett sulfamate nickel electroforming bath. (See Fig. 4, below left).

9. After electroforming in the bath was complete, the rubber casting was removed and separated from the metal. The negative metal impression of the wood surface was then trimmed to fit the platen of the sheet embossing press on which it was to be used. The metal "mold" was now available for the embossing of any product that is supposed to have the appearance of wood.

The process could have been just as easily applied to make cavity inserts, liners, embossing plates for calender rolls, or other plastic fabricating equipment components. The rubber castings made in this way can be kept for use in making several duplicate dies. Although only about 10 dies were made from the original casting described above, conceivably the rubber casting could be used to produce any number of dies required. The polysulfide rubber castings appear to have an indefinite life.—**End**

Mold design for expandable polystyrene — Part II

Factors involved in the selection of materials of construction and fabricating techniques for optimum mold performance

By Frank Lambert*

Herein are discussed the materials of construction and the methods of manufacture used to build polystyrene foam molds. (Part I of this two-part article [MPI, Nov. 1961, p. 109], discussed the geometrical and functional details involved in the design of such molds.)

Mold metals

As implied in the first part of this article, molds for the production of expandable polystyrene (PS) foam parts are normally heated with steam and cooled with water and are generally made of metal. It is highly desirable that the mold be capable of withstanding being heated and cooled rapidly to minimize the over-all molding cycle. In normal operation, foam molds will be cycled between bead-fusion temperatures around 230° F. and part-ejection temperatures of about 60 to 70° F. Thus, the mold metal selected should have as low a heat capacity and as high a thermal conductivity as possible. However, note that it is the net thermal capacity and thermal conductivity of the cavity, or core plate, that are important and not simply the inherent thermal properties of the mold metal. For example, a thin-walled stainless steel cavity will have a lower heat capacity and higher thermal conductivity than will a heavy-walled, aluminum-cavity plate, since the thinner wall of the steel plate, made possible by the greater structural strength of the steel, more than offsets the better inherent thermal properties of the aluminum metal.

Since the mold will have to operate in the presence of water, a second criterion for selecting the metal of construction is the metal's corrosion resistance. For products which may require a high-gloss surface, it is desirable that the mold metal take on a high polish.

The need for corrosion resistance excludes the selection of many materials otherwise desirable. With one exception, non-ferrous metals are generally a must. Ordinary mold steel is seldom used for three reasons: it rusts, it is costly to machine, and it has poor thermal properties. Steel can be used if plated to resist corrosion; however, the entire mold, including the inside of the steam chest has to be plated. The inside of the chamber must be plated, otherwise rust and scale in the steam chest will eventually clog the tiny steam ports connecting the steam chamber to the cavity proper. Since the plating job can get complex, it usually increases the cost of the mold and is normally unadvisable. When steel is used for foam molds it must be a stainless alloy.

In addition to having better corrosion resistance, non-ferrous metals usually surpass steels in thermal properties which are important factors in determining the mold cycle. The table below compares qualitatively the pertinent physical properties of the various metals currently being used for steam-heated foam molds. The high-frequency electrically heated mold is another subject in itself and will not be covered here; such molds are not normally made of metals.

With reference to the table, alum-

*Director of Research and Development, Champlain-Zapata Plastics Machinery Inc., W. Caldwell, N. J.

Comparison of expandable polystyrene foam molds

	Aluminum	*Bronze*	*Stainless steel*	*Nickel*
Made by	Casting or fabrication	Casting or fabrication	Hydroforming or spinning	Hydroforming or spinning
Weight	Medium	Heavy	Light	Light
Surface polish	Fair	Good	Excellent	Excellent
Life expectancy (surface)	Fair	Good	Excellent	Excellent
Strength to weight ratio[a]	Good	Fair	Excellent	Excellent
Need for release agent[b]	Continuous	Intermittent	None	None
Heat dissipation factor[c]	Poor	Fair	Good	Good
First cavity cost	Low	Medium	[d]	[d]
Repeat cavity cost	Low	Medium	Low	Low
Wall thickness, in.	3/8 +	1/4 +	Approx. 1/16	Approx. 1/16
Cycle speeds	Medium	Good	Fast	Fast
Dimensional stability	Fair	Good	Excellent	Excellent

[a]Refers not to inherent properties of metals, but to properties after fabrication into PS foam molds. [b]If Teflon coated can be treated intermittently but slower cycles can be expected. [c]Due to wall thickness needed for required strength. [d]Where spinning is used, cost is medium. Where hydroforming is used, cost is high, except for repeats.

inum, although apparently the least desirable material for mold construction, is ironically the most popular material. Reason for this is the low cost of cast aluminum molds. From a technical standpoint cast aluminum molds are not desirable since they must be made with heavy sections and it is difficult to get a high polish on the cast material, especially sand-cast molds. The heavy section, of course, cancels out the inherently better thermal properties of aluminum, and aluminum molds will not cycle as fast as molds of other metals which may be used in thinner sections. Of course, aluminum does have adequate resistance to water corrosion and, in non-critical jobs and those in which initial budget is restricted, aluminum is entirely satisfactory.

Bronze is replacing aluminum in many applications, even though it costs more. It is much stronger than aluminum and, although much denser, may be cast in thinner sections—which compensates for its higher specific gravity. Furthermore, bronze has an inherently higher thermal conductivity than does aluminum. Consequently, bronze molds will operate on faster cycles. Bronze will also take and hold a high polish and is easily plated with either hard chromium or nickel; aluminum is very difficult to plate, and few platers will attempt it.

In addition, bronze is a work-hardening material and molds wear better. This property is especially important on mating mold surfaces, where it helps prevent damage from PS beads accidentally trapped in closing the mold. Such damage can cause steam leaks and loss of steam pressure control during molding.

Stainless steel is the third metal commonly used in foam molds. Molds are made from sheet by either spinning or hydroforming. Because of the strength of steel, mold cavity and core walls can be as thin as 60 to 80 mils, compared with 3/16 to 3/8 in. for cast bronze or aluminum. The ability to use the thin wall results in molds which have less thermal inertia than either bronze or aluminum molds and which cycle considerably faster. In an actual comparison, a 60-mil-wall stainless mold ran an average of at least twice as fast as a comparable 1/4-in.-wall aluminum mold.

Another major advantage of the stainless steel is that it needs no release coating. No sticking occurs if mold temperature is controlled.

Hard nickel sheet is used to fabricate molds in a manner similar to stainless steel. Hard nickel has one advantage over stainless: its greater ductility. Spun or hydroformed, it may be used for shapes too complex for the stainless steel. However, it is not as strong as stainless and a thicker wall may be necessary. Although this lengthens cycle somewhat, the cycle of a hard nickel mold is still vastly superior to that of aluminum or bronze molds. The big disadvantage of stainless steel and nickel is their higher cost.

Methods of mold construction

Casting. This is the most popular method for making foam molds. The reason is the relative simplicity of the process. Casting eliminates the need for cutting away large amounts of unwanted metal and produces a mold in a shorter time at lower cost than machining.

The cost differential between casting and cutting a foam mold is even greater than the differential between casting and cutting a compression or injection mold. This is because in foam molds not only must the cavity be cut, but the back side of the cavity must be contoured to the shape of the cavity itself. (See Figs. 1 and 2 in Part I). The contouring is required to produce a uniform **(To page 196)**

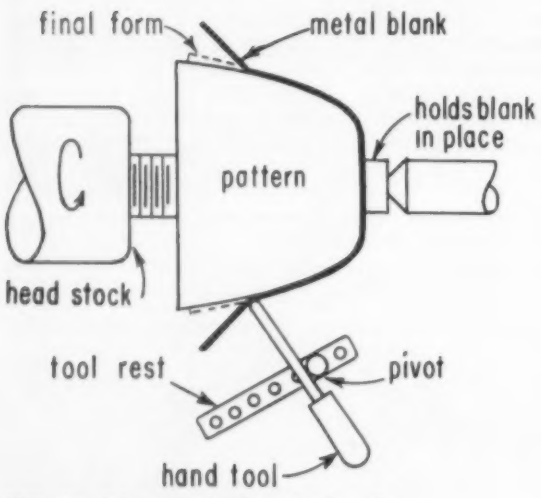


FIG. 12: Schematic drawing showing the principles of making spun mold cavity plates. Method is limited to the forming of solids of revolution. A separate wood or metal pattern is required for each shape to be made; however, several duplicates can be made from the same master pattern.

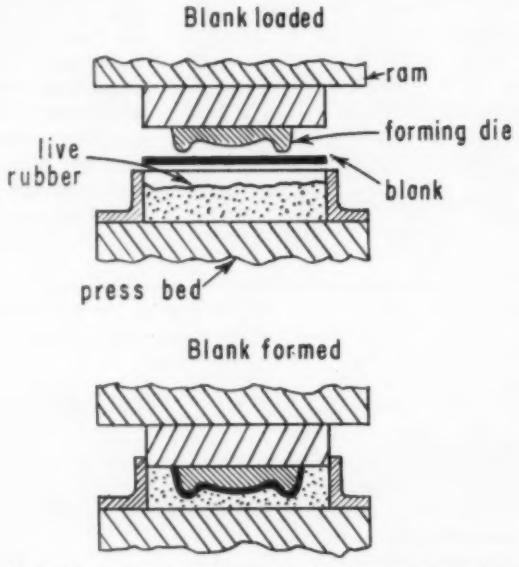


FIG. 13: Schematic drawing showing how cavity or force plates may be made for foam molds using the hydroforming technique. Live rubber pad is contained, and, when compressed, acts as hydraulic fluid to press sheet metal blank over the master cavity pattern or forming die. Hydraulic action of rubber produces intimate contact of the metal sheet uniformly in all areas.

Programs scheduled for...

18th ANNUAL TECHNICAL CONFERENCE

PITTSBURGH
Jan. 30 to Feb. 2, 1962

17th ANNUAL REINFORCED PLASTICS CONFERENCE

CHICAGO
Feb. 6 to 8, 1962

18th Annual S.P.E. Technical Conference

The 18th Annual Technical Conference of the Society of Plastics Engineers Inc. will be held Jan. 30-Feb. 2, 1962, at the Penn-Sheraton Hotel, Pittsburgh, Pa. The tentative program follows:

Tuesday, Jan. 30

Session 1: Test methods

"Simulated rocket environments for material screening." *G. C. Boyd and K. R. Hoffman, Dow Corning Corp.*

"A compound pendulum for dynamic viscoelastic property measurements." *L. A. Rosenthal and A. J. Ungerman, Union Carbide Plastics Co.*

"Stress-cracking of rigid thermoplastics." *R. L. Bergen, Naugatuck Chemical Co.*

"Evaluation of injection-molded thin-wall polystyrene containers." *F. J. Pokigo and R. E. Flodman, Monsanto Chemical Co.*

Session 2: Electrical insulation

"The development of castable urethane elastomers." *L. I. Johnson, Minneapolis-Honeywell Regulator Co.*

"Dynamic mechanical properties of epoxy resins." *C. A. May and F. E. Weir, Shell Development Co.*

"Physical testing of epoxy fluidized-bed coatings." *D. L. Slater and A. J. Good, Armstrong Resins Inc.*

"Properties of high-temperature epoxy systems." *L. S. Buchoff and W. R. Sherwin, Electro-Tac Corp.*

Session 3: Plastics auxiliary equipment

"In-plant material handling and drying." *H. Whitlock, Whitlock Associates Inc.*

"Temperature control as applied to the plastics industry." *R. H. Dean, Sterling Inc.*

"Water conservation and chilling as applied to plastic processing." *C. E. Waters, Application Engineering Corp.*

"Static electricity in plastics—cause, effect, and elimination." *W. W. Levy, The Simco Co.*

Session 4: Coloring in plastics

"Color as an engineering material." *M. Saltzman, Allied Chemical Corp.*

"On order in color and coloring." *G. Ingle, Monsanto Chemical Co.*

"Procedures for instrumental color control." *H. Hemmendinger, Davidson and Hemmendinger Co.*

Session 5: Electrical insulation panel

Topic: "Determining tomorrow's require-

Pull out

ments for plastics in electrical insulation." *Panel: To be announced later.*

Session 6: Extrusion, Part 1

"Extrusion and evaluation of thin-gage, high-impact polystyrene sheet." *F. J. Pokigo and M. J. Roman, Monsanto Chemical Co.*

"Techniques for securing gloss on extruded high-impact polystyrene sheet and their effect on sheet properties." *R. O. Carhart, D. A. Davis, and R. Giuffria, General Electric Co.*

"Performance characteristics of metering-type screws on acrylic materials." *R. T. Cassidy and J. F. Garber, Rohm & Haas Co.*

Wednesday, Jan. 31

Session 7: Extrusion, Part 2

"Theory and operation of the two-stage single-screw extruder." *B. H. Maddock and P. P. Matzuk, Union Carbide Plastics Co.*

"Dynamic valving *vs.* static valving." *H. E. Sponaugle, Black-Clawson Co.*

"Process dynamics of screw extrusions." *R. Kirby, Minnesota Mining & Mfg. Co.*

"Experimental illustration of dynamic extrusion theory." *W. Krueger, Minnesota Mining & Mfg. Co.*

Session 8: Reinforced plastics

"A method for measuring tensile properties of glass filament roving." *S. Brelant, Aerojet-General Corp.*

"Glass reinforced organic resin laminates for service to 600° F." *J. H. Freeman, E. J. Traynor, J. Miglarese, and R. H. Lunn, Westinghouse Electric Corp.*

"Designing fire retardance into reinforced polyester structures." *A. J. Hammerl, Hooker Chemical Corp.*

"A unique process for producing monolithic insulated structures of reinforced plastics for hypersonic re-entry bodies." *R. H. Lunn, T. R. DeLoach, and C. M. Holmes, Westinghouse Electric Corp.*

Session 9: Blow molding

"Low-cost injection blow molding." *J. N. Scott and D. L. Peters, Phillips Chemical Co.*

"Measurement of blown container stress-crack resistance." *J. P. Fogerty and J. J. Whidden, W. R. Grace & Co.*

"Improving surface of blow-molded products." *D. L. Peters, T. E. Branscum, R. Doyle, and J. N. Scott, Phillips Chemical Co.*

"Blow molding expandable polystyrene." *A. J. Fox and H. H. Goldsberry, Koppers Co. Inc.*

Session 10: Extru

Topic: "What is an extru
design—*N. Wheeler, Davis-*
truder drives—*P. Moroz,*
ducers and thrust bearings
tional Rubber Machinery
cooling systems—*P. Squires*

Session 11: Reinforced

"Preparation of a materia
for structural plastics." *C.*
cuse University; A. Dietz,
Naval Ordnance Laboratory
est Products Laboratories.

Session 12: F

"Thermoforming aspects
SAB terpolymer." *W. W. R*
Varholak, Monsanto Chem

"Distortion printing and
forming of thermoplastic sh
Eastman Chemical Product

"Plug-assist reverse draw
Aslakson, Dow Chemical

Session 13: F

"Evaluating lacquer and
in surfaces." *E. A. Smith,*

"Color considerations i
tics." *R. E. Dunning and*
Chemical Co.

Thursday, J

Session 14: Vinyl

"A new method for ach
dry blends." *G. Sterns, En*

"Centrifugal casting of
D. Spencer, Allied Chemic

"Process for making el
molds for rotation and slu
tisols and organosols." *R.*
ley's Plastic Products Inc.

"The future of calenderi
dustry." *S. E. Perlberg, A*

Session 15: Injection

"Plunger screw *vs.* con
tion in injection molding."
J. W. Mighton, Dow Chem

"The effect of pressure
perature." *R. Burkhalter,*
W. Georgi, The Parker P

"Flow properties of the
tion molding." *R. B. Stau*

"Moldability of plastics
ogy." *F. E. Weir, Shell De*

: Extrusion panel

an extruder?" Panel: Screw
r, Davis-Standard Co.; Ex-
Moroz, Du Pont; Gear re-
bearings—*E. Heston, Na-*
achinery Co.; Heating and
P. Squires, Du Pont.

inforced plastics panel

a materials design handbook
ics." *C. S. Grove Jr., Syra-*
. Dietz, MIT; H. A. Perry,
aboratory; F. Wehren, For-
ratories.

n 12: Forming

g aspects of abuse-resistant
W. W. Robertson and E. H.
io Chemical Co.

ting and subsequent vacuum
plastic sheet." *R. F. McTier,*
l Products Inc.

erse draw forming." *R. C.*
hemical Co.

n 13: Finishing

quer and decorating Polylef
. Smith, W. R. Grace & Co.

rations in decorating plas-
ing and T. E. Hayden, Bee

sday, Feb. 1

l: Vinyl processing

l for achieving dispersion in
erns, Entoleter Inc.

sting of thermoplastics." *C.*
l Chemical Corp.

aking electroformed copper
n and slush molding of plas-
sols." *R. H. Pasley Sr., Pas-*
ucts Inc.

calendering in the plastics in-
rlberg, Adamson United Co.

jection molding, Part 1

vs. conventional plasticiza-
molding." *L. W. Meyer and*
ow Chemical Co.

pressure on plastic melt tem-
rkhalter, W. Tychesen, and
Parker Pen Co.

es of thermoplastics in injec-
B. Staub, Union Carbide.

plastics based on melt rheol-
Shell Development Co.

Session 16: Polymer properties

"Determination of the degree of crosslinking of carbon-black-loaded polyethylene compounds." *B. B. Boonstra, Cabot Corp.*

"Effects of molecular-weight distribution on the melt rheology of polyethylene." *H. L. Wagner and K. F. Wissbrun, Celanese Polymer Co.*

"Stress relaxation in aggressive environments." *R. McFedries, Dow Chemical Co.*

"Photoelastic phenomena in plastics during impact." *N. W. Hall, R. E. Wright, and W. C. Smith, Shell Chemical Co.*

Session 17: Vinyl plastics panel

Topic: "Differences between European and American vinyl plastics practices." Panel: Equipment—*S. E. Perlberg, Adamson United Co.;* Equipment—*A. A. Kaufman, Prodex Corp.;* Raw materials—*A. Hecker, Argus Chemical Corp.;* Markets—To be announced.

Session 18: Injection molding, Part 2

"An accurate measurement of nozzle pressures during injection molding." *H. W. Ashton and R. T. Cassidy, Rohm & Haas Co.*

"A method for measuring plastic melt temperatures during injection molding." *W. Tychesen and W. Georgi, The Parker Pen Co.*

"The measurement and evaluation of heating cylinder capacities using polyolefinic resins." *C. L. Weir, W. R. Grace & Co.*

Session 19: Thermosetting molding

"The effect of preforming and preheating on fibrous-filled diallyl phthalate and epoxy." *J. A. Woolf, Mesa Plastics Co.*

"Compression and transfer molding." *E. F. Borro Sr., Durez Plastics.*

"New developments in automatic transfer molding of thermosetting compounds." *J. L. Hull, Hull Corp.*

Friday, Feb. 2

Session 20: Foams

"Environmental factors in thermal conductivity of plastic foams." *R. E. Skochdopole and G. A. Patten, Dow Chemical Co.*

"Improvements in steam molding of expandable polystyrene." *R. H. Immel, Koppers Co.*

"Packaging with foams." *R. G. Hanlon and W. E. Humbert, Dow Chemical Co.*

"Injection molding foamable polystyrene." *L. W. Meyer, Dow Chemical Co.*

Session 21: Polyolefins

"Physical properties of ethylene/1-olefin copolymers." *V. L. Folt, B. F. Goodrich Co.*

"A new flexible ethylene copolymer." *S. Bonotto and B. H. Krevsky, Union Carbide.*

"Low-shear viscosity of high-density PE and ethylene copolymers." *R. H. McGlamery and A. A. Harban, Phillips Petroleum Co.*

"Ductile failure mechanism in PE pipe under constant pressure." *S. A. Mruk, Allied Chemical.*

Session 22: Vinyl plastics

"Vinyl plasticizers from trimetallic anhydride." *F. A. Cassis and P. C. Dougherty, Amoco Chemicals Corp.*

"Some factors influencing odor development and inhibition in plasticized polyvinyl chloride." *J. K. Sears and J. R. Darby, Monsanto.*

"Stabilization of rigid polyvinyl chloride formulations for outdoor exposure." *N. L. Perry, Argus Chemical Corp.*

"Properties of rigid PVC pipe produced from powder compound." *J. A. Rolls and P. S. Weill, Diamond Alkali Co.*

17th Annual S.P.I. Reinforced Plastics Conference

Registration for the 17th Annual Conference of The Society of the Plastics Industry Inc. will begin at 1:00 p.m. on Monday, Feb. 5, 1962, in the main lobby foyer of the Edgewater Beach Hotel. The tentative program follows:

Tuesday, Feb. 6

9:30 A.M. to 12:00 Noon—
Three concurrent sessions

Session 1: Research and filament winding, Sections B and C. *Presiding: Frederick J. McGarry, MIT. Vice Chairman: Harry E. Pebly, Jr., Plastics Technical Evaluation Center.*

"Engineering properties of high modulus reinforced plastics." *George P. Peterson Aeronautical Systems Div., Wright-Patterson Air Force Base, Ohio.*

"Strength properties of high modulus glass fibers using the NOL ring test." *P. W. Erickson, F. Robert Barnet, H. A. Perry, and Sidney Karpe,* Naval Ordnance Lab., Silver Spring, Md.

"Flexural fatigue testing of polyesters." *Erling Hagerup, California Research Corp.*

Program continued on reverse side

"Cyclic pressure testing of reinforced plastic pipe." *F. R. Pflederer, A. O. Smith Corp.*

Session 2: Design. *Presiding: George Lubin, Grumman Aircraft Engineering Corp. Vice Chairman: H. T. Plant, General Electric Co.*

"Glass fiber reinforced plastics in highly-stressed aircraft parts." *Rudolf Abelin, M. Flygindustri, Bulltofta Flygplats, Malmo C, Sweden.*

"Designing with glass bands." *A. G. Pehrson, General Electric Co., Direct Current Motor and Generator Dept.*

"Thermal expansion of reinforced plastics." *L. S. Lazar and C. D. Doyle, General Electric.*

"Development of a directed fiber FRP helicopter rotor blade." *Benjamin Posniak, PE, Kaman Aircraft Corp.*

"Experimental methods for evaluating performance of ablative plastics." *Herbert S. Schwartz and Donald L. Schmidt, Plastics & Composites Branch, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.*

Session 3: Materials. *Presiding: Thomas J. Jordan, General Electric Co. Vice Chairman: K. Telford Marshall, Whirlpool Research Labs.*

"The use of polyester resin automotive body solders." *E. R. Pelton, Plastics Div., Archer-Daniels-Midland Co.*

"Use of hydroquinone derivatives as polymerization inhibitors in unsaturated polyesters." *Daniel L. Edwards Jr. and Paul T. Von Bramer, Eastman Chemical Products Inc.*

"Peroxide curing of unsaturated polyesters. II. Difunctional peroxides in premix molding." *D. C. Noller, H. N. Schack, W. F. D'Amico, and H. J. Duprez, Wallace & Tiernan Inc.*

"Pres-Tock—a new material for compression molding." *P. E. Caron and L. E. Lydic, Weyerhaeuser Co.*

"Laminates based on epoxidized polymers and copolymers of butadiene." *Christian W. Johnston and Charles G. Cullen, FMC Corp.*

Technical reference papers

"Variation of properties of an isophthalic polyester with molecular weight and styrene dilution." *Karl Schmidt, Interchemical Corp.*

"The effect of formulation and process variables on polyester resin performance." *Robert H. Leitheiser and M. D. Dalluge, Archer-Daniels-Midland Co.*

"Quantitative differential thermal analysis of epoxy resins and hardeners." *Rudolph J. Arnold Sr. and J. S. Barshatky, Sperry Gyroscope Co., Materials Laboratory, 1P39.*

12:30 to 2:00 P.M.—Luncheon

Welcoming address and presiding: Dr. Harry R. Nara, Case Inst. of Tech. Principal speaker: Robert S. Morrison,
Subject: "The honey

8:0

Session 1: Premix,
siding: Robert J. Brin
of C. Beetle. Vice Ch
Consultant.

"Market potentials
B. White, The Glasti

"Asbestos in polye
pounds." *J. J. Tho*
Johns-Manville Rese

"Polyester high str
ables involved and lin
ert B. Johnson, Reich

"WEF—a new plas
Douglas fir bark." *K*
ser Co.

"Formulation of p
in hot aqueous soluti
Booker, and S. S. Fe

"Recent technical
ments in dough m
mix)." *N. A. Cutler,*
Parker, B. I. P. Ch

"Premix mixing pr
Calderwood and A. J

"High strength
compound." *J. N.*
Minnesota Mining &

Seminar panel—a

Wednes

9:00 A.M. t

Three conc

Session 1: Resear
Part II, Sections B a
Pebly Jr., Plastics T
ter, Picatinny Arsena
man: Frederick J. M

"Filament windi
Allen M. Shibley, I
Eig, Dept. of Defen
uation Center, Picat

"Recent advances
plastic rocket motor
Research Laborator
Special Projects Offi

"Designing epoxy
ment winding." *Jo*
Welch, and Frank M
Plastics Co.

"Parameters of
ance." *James A. M*
Chemicals Inc.

"Radiographic in

Morrison, Molded Fiber Glass Co.
he honeymoon's over."

8:00 P.M.

: Premix, Sections B and C. *Pre-*
rt J. Brinkema, Firmaline Division
Vice Chairman: P. Robert Young,

potentials and applications." *Roger*
he Glastic Corp.

in polyester premix molding com-
J. Thomas and R. T. Crouch,
ille Research Center.

r high strength glass premix—vari-
ed and lines of improvement." *Rob-*
on, Reichhold Chemicals Inc.

new plastics reinforcing fiber from
bark." *Keith D. Gehr, Weyerhaeu-*

tion of premix compounds for use
ous solutions." *J. O. Yovino, B. E.*
S. S. Feuer, Atlas Chemical.

technical and application develop-
dough molding compounds (pre-
A. Cutler, J. E. Ferriday and F. J.
I. P. Chemicals Limited, England.

mixing procedures, a study." *R. H.*
and A. J. Hovanec, Westinghouse.

trength fiberglass-epoxy molding
J. N. Schurb and R. F. Coad,
Mining & Manufacturing Co.

panel—all speakers to participate.

Wednesday, Feb. 7

A.M. to 12:00 Noon—
ee concurrent sessions

: Research and filament winding,
tions B and C. *Presiding: Harry E.*
Plastics Technical Evaluation Cen-
y Arsenal, Dover, N. J. Vice Chair-
rick J. McGarry, MIT.

t winding, the state-of-the-art."
Thibley, Harvey Peritt, and Merrill
of Defense, Plastics Technical Eval-
er, Picatinny Arsenal, Dover, N. J.

advances in glass fiber reinforced
et motors." *J. A. Kies, U. S. Naval*
Laboratory and Harold Bernstein,
jects Office, Navy Dept.

ng epoxy resins specifically for fila-
ing." *John J. Madden, John L.*
Frank McAndrews, Union Carbide

ters of prepreg *vs.* end perform-
es A. Martenson, U. S. Polymeric
Inc.

aphic inspection of glass fiber rein-
forced plastics." *H. A. Perry Jr., Naval Ordnance Laboratory, Silver Spring, Md.*

"Large reinforced plastic rocket cases." *Charles Tanis, Aeronautical Systems Div., Manufacturing Technology Laboratory, Wright-Patterson Air Force Base, Ohio.*

Session 2: Space applications. *Presiding: George Epstein, Aeronutronic, A Division of Ford Motor Co. Vice Chairman: George Lubin, Grumman Aircraft Engineering Corp.*

"Aerospace use of plastic hardware and thermal insulation." *James Sewell and James Kuno, Telecomputing Corp., Narmco Materials Division.*

"The role of reinforced plastics in future space vehicles." *Leo E. Gatzek and C. R. Feller, Aerospace Corp.*

"Materials for internal thermal protection of rocket motor cases." *George Epstein and E. H. Jaffe, Aeronutronic, Div. of Ford Motor Co.*

"Plastics of high strength/weight ratio for space applications." *A. J. Dervy, Rocketdyne Division, North American Aviation Inc.*

"The ablation of reinforced plastics." *Dr. S. Brelant and P. Joerg, Aerojet-General Corp.*

Technical reference paper

"Filament reinforced plastics for space vehicles and satellites." *Ralph J. Brown Jr., Lockheed Missiles & Space Co.*

Session 2: Transportation. *Presiding: Robert A. Winblad, Cimastra Div., Cincinnati Milling & Grinding Machines Inc. Vice Chairman: Robert A. White, Celanese Polymer Co.*

"Application of reinforced plastics to heavy-duty earth moving equipment." *John A. Peasley, Caterpillar Tractor Co.*

"Structural use of reinforced plastic in truck trailer construction." *Morgan Martin, Molded Fiber Glass Body Co.*

"Use of reinforced plastic in standard containers for freight interchange." *John F. Reeves, Litewate Engineering.*

"Reinforced plastics and typical applications on Boeing transport airplanes." *William H. Fetherston, Boeing Airplane Co.*

"Current (Status) use of reinforced plastic in commercial aircraft." *Paul Layton and William Featherstone, Owens-Corning Fiberglas.*

Technical reference paper

"Current status of F.R.P. and marine applications." *Frank M. Stagl, Lunn Laminates Inc.*

12:30 to 2:00 P.M.—
Presidents' luncheon

Presiding: George A. Stein, Archer-Daniels-Midland Co. Principal Speaker: Senator Everett M. Dirksen (R., Ill.).

6:00 to 7:00 P.M.—Reception. Sponsored by Materials Companies Sections B and C.
7:00 P.M.—Annual banquet

Toastmaster: Samuel A. Moore, Interchemical Corp. and General Chairman of S.P.I. Reinforced Plastics Division. Executive committee awards.

Thursday, Feb. 8

9:00 to 12:00 Noon—
Three concurrent sessions

Session 1: The glass-resin interface, Part I, Sections B and C. *Presiding: William J. Eakins, DeBell & Richardson Inc. Vice Chairman: William J. Diamond, The Brunswick Corp. Introductory Remarks: Mr. Eakins.*

"Some further studies on the effect of glass-resin type and cure on the strength of laminates." *K. J. Brookfield and D. Pickthall, Fibreglass Limited, England.*

Comments on this paper by *Paul C. Yates, Du Pont.*

"Investigations on the strength of alkali containing glass fibers." *Hans Weisbart, Glaswerk Schuller GmbH, Wertheim/Main, W. Germany.*

Comments on this paper by *Robert R. Stromberg, Plastics Section, National Bureau of Standards.*

"Studying the reactivity of various fibrous glass surfaces as formed, after heat soaking and after mild acid leaching." *William J. Eakins, DeBell & Richardson Inc.*

Comments on this paper by *Charles M. Hollabaugh, Pittsburgh Plate Glass Co.*

"The bonding of fillers and fibers to thermosetting resins." *Byron M. Vanderbilt and John J. Jaruzelski, Esso Research & Engineering Co.*

Comments on this paper by *Robert L. Patrick, Alpha Research & Development Inc.*

"Theoretical and experimental stress studies at the glass-resin interface." *W. H. Otto, Narmco Research & Development, and S. Dharmarajan, San Diego State University.*

Comments on this paper by *H. A. Perry Jr., Naval Ordnance Laboratory, White Oak, Silver Spring, Md.*

Technical reference paper

"The effect of thermosetting resins on the strength of glass." *O. Ozaltin and John O. Outwater, The University of Vermont.*

Session 2: Environmental resistance. *Presiding: Jack C. Schlegel, American Cyanamid Co. Vice Chairman: Kenneth H. Wanderer, FMC Corp.*

"Resistance of reinforced plastics to weath-

ering." *George R. Rugger and Cecilia McNally, Picatinny Arsenal, Dover, N. J.*

"Energy measurements for correlation among outdoor and indoor light stability tests." *I. H. Updegraff, R. C. Hirt, and P. Giesecke, American Cyanamid Co.*

"The role of oxidation in the weathering properties of polyester reinforced plastics." *George H. Hicks, Reichhold Chemicals Inc.*

"Exposure testing of fibrous glass-reinforced plastic." *Grace Moore, Molded Fiber Glass Body Co.*

"An investigation of the optical properties of fibrous glass-reinforced translucent panels. Part II. An interim report." *John B. Crenshaw and Daniel Smith, Interchemical Corp.*

Session 3: Plastics in building. *Presiding: Costa J. Gongolas, Pittsburgh Plate Glass Co. Vice Chairman: George A. Stein, Archer-Daniels-Midland Co.*

"Building: Some basic facts for the plastics industry." *H. Horowitz, Building Research Inst.*

"Design and prototype construction of flexible, segmental school building." *Marvin S. Goody, MIT.*

"The use of reinforced plastics for concrete forms." *E. R. Pelton, Plastics Div., Archer-Daniels-Midland Co.*

"Plastics in architecture—the craft approach." *George Kreier Jr., Architect.*

"Plastics for building exteriors—roofs and walls." *Prescott Coan and Robert R. Keller, Kalwall Corp.*

Technical reference papers

"Reinforced plastics in composite structures." *Albert G. H. Dietz, MIT.*

"Development of N.S.P.I. minimum standards for construction, installation, and maintenance of fibrous-glass swimming pools." *J. Gilbert Mohr, Johns-Manville Fiber Glass Inc.*

"Burning tests for thermosetting resins." *Andrew J. Hammerl, Durez Plastics Div., Hooker Chemical Corp.*

12:30 to 2:00 P.M.—Award luncheon

Presiding: James S. Lunn, Lunn Laminates Inc. Principal Speaker: Maj. John J. Whiteside, USAF. Subject: "Aerospace activities at Cape Canaveral."

2:00 to 5:00 P.M.—
Two concurrent sessions

Session 1: The glass-resin interface, Part 2, Sections B and C. *Presiding: William J. Diamond, Brunswick Corp. Vice Chairman: William J. Eakins, DeBell & Richardson Inc.* Introductory remarks: Mr. Diamond.

"Evaluation of new silane coupling agents for glass fiber-reinforced plastics." *E. P. Plueddemann, H. A. Clark, K. R. Hoffman, and Lee Nelson, Dow Corning Corp.*

Comments on this paper by *C. A. Kumins, Interchemical Corp.*

"The nature, origin, and effects of internal stresses in reinforced plastic laminates." *John O. Outwater and Joseph Matta, the University of Vermont.*

Comments on this paper by *Herman Boenig, Brunswick Corp.*

"Interfacial properties of an amine modified silane and its preformed polymer at E-glass surfaces." *F. M. Young, T. G. Roskos, and H. L. Radloff, A. O. Smith Corp.*

Comments on this paper by *Kurt Gutfreund, Armour Research Foundation, Illinois Institute of Technology.*

"Shrinkage stresses in glass filament-resin systems." *William H. Haslett and Frederick J. McGarry, MIT.*

Comments on this paper by *Sam Sterman, Silicones Div., Union Carbide Corp.*

Session 2: End-product manufacture. *Presiding: Arthur J. Wiltshire, Structural Fibers Inc. Vice Chairman: A. W. Levenhagen, Molded Fiber Glass Tray Co.*

"Use of spun strand roving for preforming." *R. H. Afflerbach and W. W. Thompson, Owens-Corning Fiberglas Corp., Technical Center.*

"Quality control on the production of the 7 Gev Proton Synchrotron vacuum vessels." *I. D. Aitken, S. H. Cross, and R. Sheldon, United Kingdom Atomic Energy Authority, National Institute for Research in Nuclear Science, Eng.*

"Asbestos reinforced thermosetting resin pipe and fittings for use by the chemical process industry." *R. T. Crouch, R. M. Hutchison, J. G. Hedin, and W. O. Jackson, Johns-Manville Research Center.*

"Production and marketing of large-diameter polyester tubes in Sweden." *Axel L. Westel, AB Hoganasmetoder, Hoganas, Sweden.*

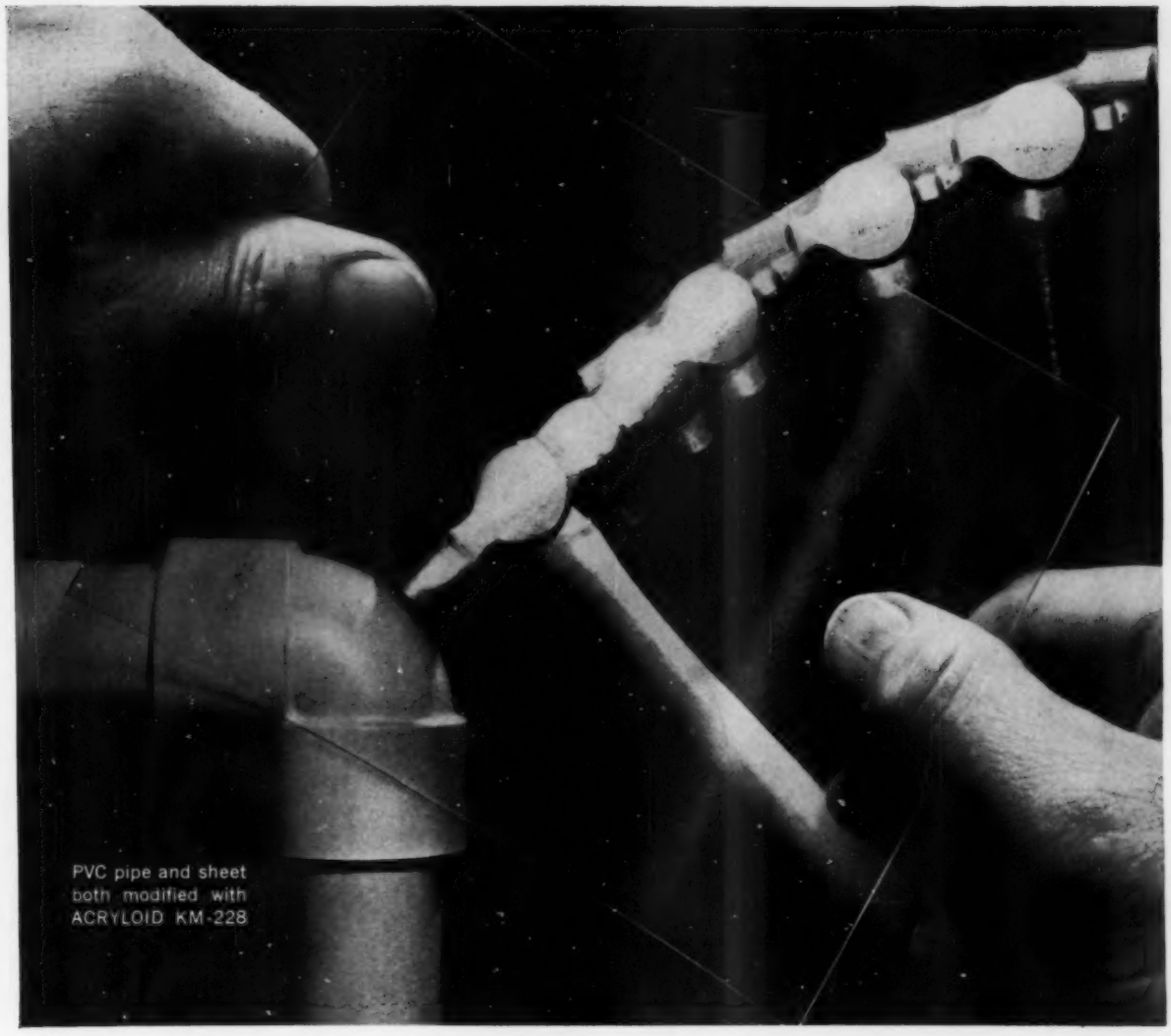
"Highway guard rail application for glass fiber-reinforced plastic." *Andrew L. Bastone, Owens-Corning Fiberglas Corp., Technical Center.*

Technical reference papers

"Equipment and technique for spray molding reinforced plastics. *Jack G. Fuller, Polymer Machinery Corp.*

"Dielectric heating in the reinforced plastics industry." *James L. Harvey, W. T. LaRose & Associates Inc.*

"A catalyst vehicle for spray molding." *G. T. Overholt Jr., FMC Corp.*—**End**



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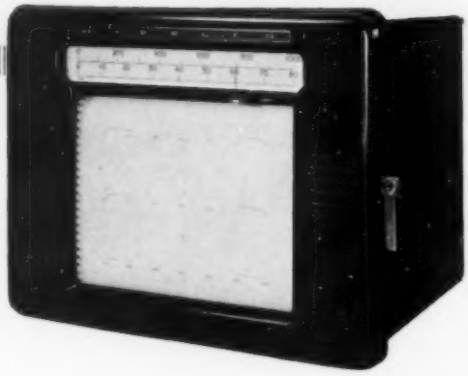

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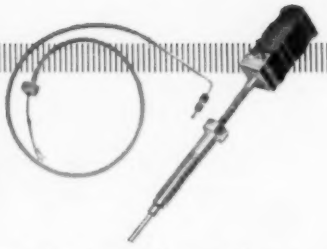

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PLASTICS* TECHNICAL SECTION

MATERIALS • PROPERTIES • TESTING METHODS AND INSTRUMENTATION • STANDARDS • CHEMISTRY

Effect of static pressure on polymer melt viscosities

By James F. Carley†

Increasing static pressure at constant pressure drop very definitely increases plastic melt viscosity, more for polystyrene than for polyethylene, but the viscosity increase is more than offset by the speed-up of flow brought about by an equal increase in pressure drop. The relationship between flow and static pressure appears to fit best the exponential form given by the Eyring equation, but it is also fitted well enough by a power-law function so that the rheologist cannot detect the static-pressure effect with present single-piston flow-tube rheometers and methods. The effect is of minor importance commercially, except when operating near the freezing range of the melt, at very high pressures.

Metzner and his coworkers (1)[1] concluded that changes in viscosity with static pressure are negligibly small over the studied range of temperature and pressure, up to 19,000 p.s.i. for low-density polyethylene. This is a direct contradiction of Westover's work (2), which showed definite, large effects of pressure on viscosity and flow. The purpose of this article is to clear up this difference of opinion.

In any body of liquid, at rest or in motion, there is pressure throughout the liquid. In a liquid at rest, this pressure is due either to its own weight or to externally applied compressive forces, or both. The pressure at the bottom of an ocean is very high because of the weight of the thousands of feet of liquid above it. The pressure on a plastic melt in an injection-machine cylinder is equally high because the ram is squeezing it with great force. As this melt flows through the injection nozzle, it passes from the high-pressure region inside the cylinder to the low-pressure region (essentially a no-pressure region) of the empty mold cavity. Thus, from the cylinder end to the cavity end of the nozzle there is a *drop* in the pressure of the melt. When the cavity is nearly full, static pressure begins to build up in it, too. When the ram comes to rest, static pressure is nearly equal throughout the cylinder, runner, and cavity (if all are still filled with melt) and the pressure *drop* across the nozzle has fallen to zero.

Most orifice-type rheometers resemble the injection cylinder in principle, except that the melt does not flow into a cavity but discharges to the open air. In the special rheometers used by Maxwell (3) and Westover (2), the orifice is located between two "injection" cylinders, each with a separately pressured piston. Such an arrangement permits the rheologist to regulate independently the *static* pressure on one side of the orifice and the pressure difference or *drop* across the orifice as the melt flows through it. This raises the following question: what static pressure is pertinent to the viscosity of the *flowing* melt? Is it the pressure on the upstream side, the downstream side, or somewhere along the tube? Maxwell implied that his "hydrostatic pressure" was the *down*stream pressure, whereas Westover said that his hydrostatic pressure was the *up*stream static pressure.

There is a time factor involved here. Westover noticed, in compressing his samples to the high operating pressure prior to running each flow test, that about 5 min. was needed to accomplish the compression. This long compression time is due to the bulk viscosity of the melt.[2] Thus, if the pressure were to be released on a melt that had been held under compression for 5 min. or more, it seems reasonable to suppose that the bulk viscosity would resist the expansion with the same reluctance that it resisted the compression, and the expansion time would also be about 5 minutes. Now if such a precompressed melt were forced through a short tube at reasonable speed, it would be into and out of the tube in much less than 5 minutes. Thus it would actually have properties close to those of the compressed liquid while flowing through the tube.

In Westover's work, the longest

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†Dept. of Chemical Engineering, University of Arizona, Tucson, Ariz.

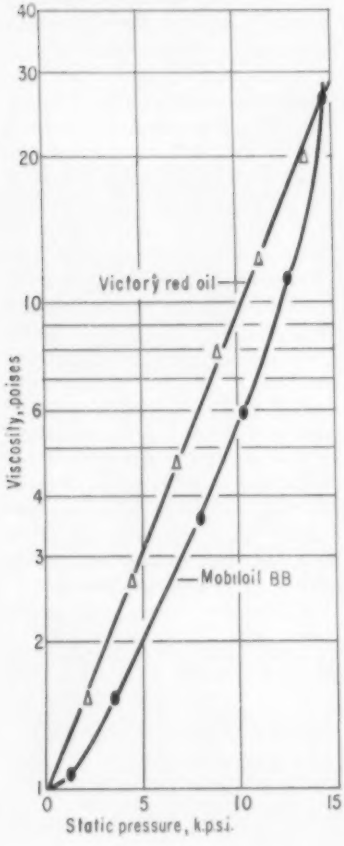
[1]Numbers in parentheses designate references at end of article, p. 205.

Based on a paper presented at the SPE 17th ANTEC, Washington, D. C., Jan. 1961.

[2]One listener pointed out that the delay in reaching the equilibrium volume may have another cause. The Joule-Thomson effect causes the temperature of the melt to rise as it is compressed. Because polymers conduct heat poorly, a long time is needed to return to the original temperature and to reach the final density associated with that temperature and pressure. Thus, what seems to be a viscous delay may be purely a thermal one, or a combination of the two. The person making this comment said that he and others had measured the decay of temperature in a suddenly compressed block of rubber and found that the time rate of change of density corresponded closely to the rate of change of temperature.

dwell time (which is easily found by dividing the apparent shear rate at the wall into eight times the L/D ratio) was about 2.7 minutes. In most of his runs, dwell time was much less, ranging from about 1 min. down to a few milliminutes. This being the case, it would seem that Westover chose wisely in basing his interpretation on the upstream static pressure, rather than the downstream or some intermediate pressure. Maxwell's dwell times were also very short, and his earlier work with the same polymers on compressibility indicates that he, too, found at least 5 min. was needed to reach the equilibrium density. So his results on viscosity at high pressures should be based, like Westover's, on the upstream static pressure. On the other hand, if one were to work with dwell times of the same order as or longer than the time required to complete compression, some thought would have to be given to the choice of a representative state for the flowing melt.

FIG. 1: Viscosity versus static pressure for two representative hydrocarbon oils. Hyde (Reference 8) used a long-capillary rheometer in order to obtain these results at differential pressures of approximately 1 p.s.i.



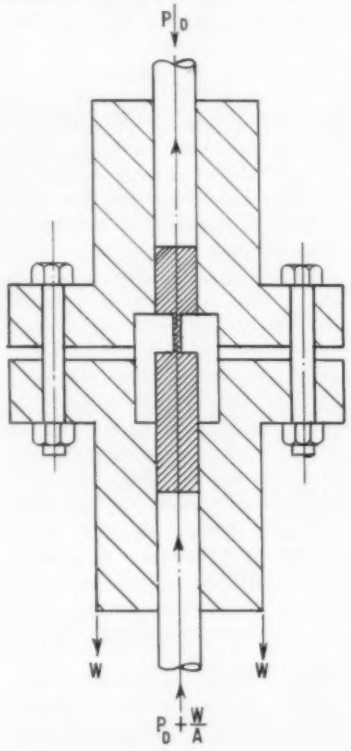
Early work

There are two routes by which we can approach the answer to the question: What is the effect, if any, of pressure on viscosity of liquids? The first is an intuitive approach. We know that when any substance, liquids included, is put under pressure, its molecules are squeezed closer together and its density increases. It seems reasonable to suppose that squeezing the molecules together will increase their resistance to flow.

The other approach was first propounded by Ewell and Eyring (4), later elaborated and reviewed in detail (5). They base their analysis on the concept that "viscous flow is assumed to take place by the activated jumping of an aggregate composed of one or more molecules from an initial normal configuration to a second normal configuration." The jumping is aided by the formation of molecular-scale "holes" in the liquid, and the molecule, or flow segment in the case of large molecules, is postulated to enter an activated state during the jump. They derived a quantitative expression giving the liquid viscosity as a function of molecular weight, absolute temperature, molecular volume, energy of vaporization, and applied pressure. This equation, they found, fitted closely the data available on viscosity versus pressure for several simple liquids. Bridgman examined its usefulness for many other liquids and found it fitted the data well, even to pressures as high as 12,000 atmospheres (6).

The quantitative application of Eyring's equation to polymer melts is not straightforward for several reasons. First, such melts are not unique molecular species; they are made up of a mixture of molecules covering a wide range of chain lengths and degrees of branching. Second, investigation has shown that large molecules do not act as units, as do the small, simpler ones. Instead, flow takes place by the activated jumping of relatively short segments of these molecules. In their review (5), Kincaid, Eyring, and Stearn state that the segments involved in the flow of long hydrocarbon molecules are about 20 to 30 chain atoms in length. Since these polymers cannot be vaporized at flow temperatures, it is difficult to arrive at an independent figure for the energy of vaporization, which is a large part of the activation-energy term of their equation. However, there are two qualitative conclusions to be drawn from the equation, and some rough calculations can be made. The first conclusion is that viscosity is a double function of absolute temperature, so the simple exponential function —one part of the double function— should not be expected to fit the data well except over narrow temperature ranges. This agrees with experiment. Second, viscosity depends on the applied pressure in a

FIG. 2: Double-piston rheometer of Maxwell and Jung (Reference 3). The static pressure was applied by the pistons of a compression-testing machine; weights hung on the block furnished the differential pressure. Heaters and temperature-control equipment are not shown in this sketch.



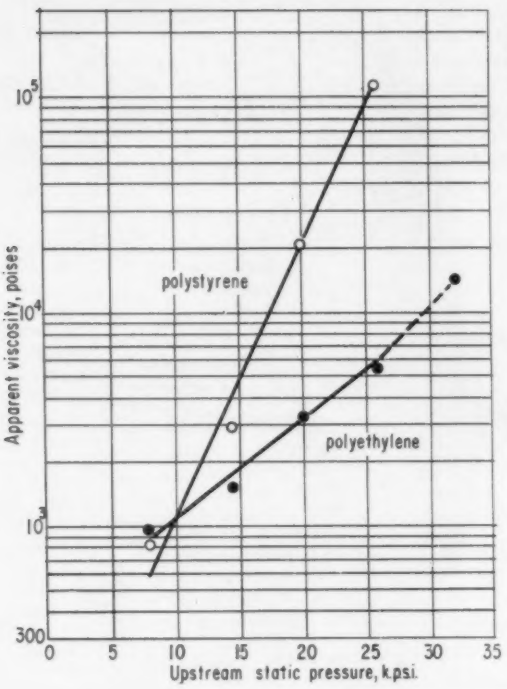


FIG 3: Corrected apparent viscosity versus upstream static pressure for polyethylene and polystyrene (Ref. 3). The data follow the predicted exponential relationship rather closely.

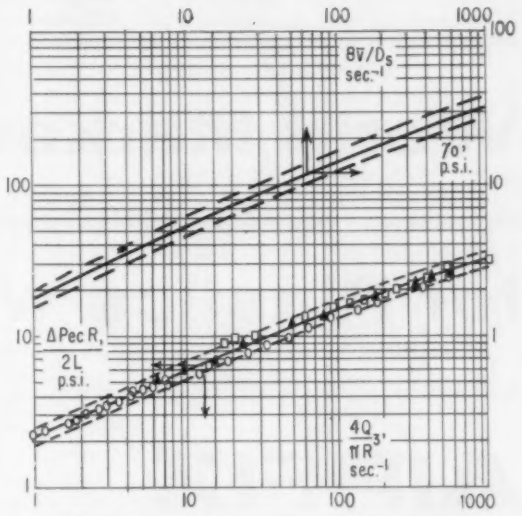


FIG. 4: Lower curve: Westover's data for three flow tubes of diameters 0.055, 0.090, and 0.125 in., all of L/D = 20. Upper curve: Metzner's data.

complex way, but can be expected to increase with increasing pressure. Further, if we put some reasonable figures for polyethylene parameters into the equation, we find that the viscosity of polyethylene should increase even more rapidly as the pressure rises higher and higher. As we shall see later in this article, this is exactly what happens.

Bridgman in a recent review (6) summarized his experience with liquids thus: "In every case . . . viscosity increases with rising pressure at constant temperature. Furthermore, the increase is, in practically every case, at an accelerated rate with increasing pressure, so that the curve of viscosity versus pressure is concave upward. . . . There is a rather close correlation between the magnitude of the effect of pressure on viscosity and the complication of the molecule. . . . The effect of 12,000 kg./cm.² [about 12,000 atm.] varies from 30% for [monatomic] mercury to a 2-fold increase for water, a 10-fold increase for methyl alcohol, a 100-fold increase for propyl alcohol, a 1000-fold increase for amyl alcohol, and an increase by 10^7-fold for eugenol. . . . The temperature coefficient of viscosity becomes markedly greater with increasing pressure." And in 1940, Newitt (7) published an almost identical analysis of the data.

Hyde (8) invented an ingenious capillary device in which to measure the flow rates of oils in the poise range at various temperatures and at static pressures up to 20,000 p.s.i., under a differential pressure of about 1 p.s.i. He also devised a simple way of measuring the compressibility of these same materials, and used his values of density at the flow pressures to obtain absolute viscosity from kinematic viscosity. He reported results for nine oils, five of them mineral oils, probably hydrocarbons. All the oils he investigated showed a highly significant and increasing rise in viscosity with increasing pressure; at 1000 atm. the viscosities of the mineral oils ranged from 8 to 35 times their 1-atm. values. For three of these oils, plots of logarithm of viscosity versus static pressure were linear, in agreement with the Eyring theory: for the other two the graphs were slightly concave upwards (see Fig. 1, p. 124). No information was given on the structures of these oils, so whether the magnitudes of the viscosity increases parallel the structural complexity of the oils is completely unknown.

The International Critical Tables (9) contain data on the viscosities of a number of liquids at high pressure. Most of the data was obtained by methods in which, even though static pressure was high, pressure drop was low, so there was no difficulty in determining which static pressure should be recorded as representative.

From the foregoing it is clear that liquid viscosities increase with pressure and that the effect is larger with more complex liquids. Molten polymers are among our most complex liquids, so we can reasonably expect that they will exhibit large pressure coefficients of viscosity. However, until Maxwell and Westover succeeded in building practical double-piston rheometers, there was no reliable way of evaluating pressure coefficients from measurements of flow rates through orifices, because in an orifice-type rheometer discharging the melt to the open air, the upstream static pressure is actually identical (in all practical measurements on plastics materials) with the pressure drop.

Thus, it is difficult, if not impossible, to reach any conclusions regarding the separate effects of pressure drop and static pressure on flow or viscosity. About the best one can do in practice is to measure the combined effects of the two factors. In the recent work of Metz-

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ner and associates (1), all the measurements were made with open-end orifices. So, although the work seems to have been first rate, it is not likely to support any conclusions concerning the effects of static pressure alone on viscosity. If such conclusions were possible, double-piston instruments would, of course, be superfluous.

The inability to discriminate between effects of static pressure and pressure drop on flow does not mean that data obtained in open-end rheometers are without value. On the contrary, since these instruments simulate more closely than other rheometers the actual conditions during injection molding or extrusion, the data obtained from them may be very useful in analyzing commercial operations. However, the investigations made in *double*-piston instruments can help to shed light on what is occurring during the last few milliseconds of the injection stroke, when the runners and cavities are filled and are in the "packing" stage.

Maxwell's data

Maxwell and Jung (3) squeezed a premolded specimen with equally loaded pistons (Fig. 2, p. 124). The pistons entered a heated block that was free to move in the vertical (piston-axial) direction. Weights hanging on the block, when released, caused it to fall, forcing the compressed molten polymer to flow up through the orifice. Results were reported for polystyrene and polyethylene at 385 and 300° F., respectively, at downstream pressures ranging from zero to 24,000 p.s.i., and at an applied pressure drop of 7880 p.s.i. (this figure was erroneously reported as the shear stress in the article; uncorrected shear stress was actually 98.4 p.s.i.). Volumetric flow rate was measured by recording the downward motion of the block and the time of flow. Orifice diameter was 0.022 in., while its length measured 20 times the diameter.

Shear stress was corrected by an unknown but probably small amount for drag between pistons and cylinder walls, but not for entrance effect. The polystyrene was identified only as a "commercial high-molecular-weight sample . . . of a pure, linear, amorphous polymer . . . [which had exhibited] in previous compressibility studies (10) no rubbery state response." The polyethylene was identified as a "commercial high-molecular-weight branched polymer, a typical example . . . of a pure, essentially linear, polycrystalline material" which had previously exhibited pressure-induced crystallinity at 300° F. at the upper end of the static-pressure range used in the flow experiments.

Maxwell and Jung observed a sharp increase in the apparent viscosities of both of these polymers with increasing static pressure. However, apparent viscosity is simply the ratio of shear stress at the orifice wall to the apparent shear rate at the wall. In Maxwell and Jung's work, where the tube dimensions were not varied, this simplifies to the ratio of pressure drop to rate of fall of the block. Further, since the pressure drop was kept constant at 7880 p.s.i., Maxwell's apparent viscosities are simply in inverse proportion to the observed rate of fall. Now, in flow measurements with single-piston instruments it has been observed that in high-shear range, apparent viscosity *increases* as apparent shear rate (and shear stress) *decrease*. In Maxwell's case, too, apparent viscosity is increasing as shear rate decreases. Hence Metzner's comment (11) that the report of Maxwell and Jung ". . . does not separate changes in apparent viscosity due to varying shear rate from pressure-induced changes."

This seeming confusion between the effects of static pressure and shear rate is cleared up by adopting a slightly different point of view in examining the data. Since the relationship between pressure drop and flow rate has been proved to be unique for a given material if there is neither slip at the wall nor time-dependency of properties, it is immaterial whether apparent viscosity is thought of as depending on the shear stress (*i.e.*, pressure drop) or the shear rate (*i.e.*, flow rate). Therefore, let us view it as a function of the shear stress at any given temperature and static pressure; assume also that the functional relationship of apparent viscosity to shear stress and static pressure is the product of two separate functional relationships—the sort of multi-variable functionality that is almost universal in the engineering realm. (Actually, Westover's data indicate that just this type of func-

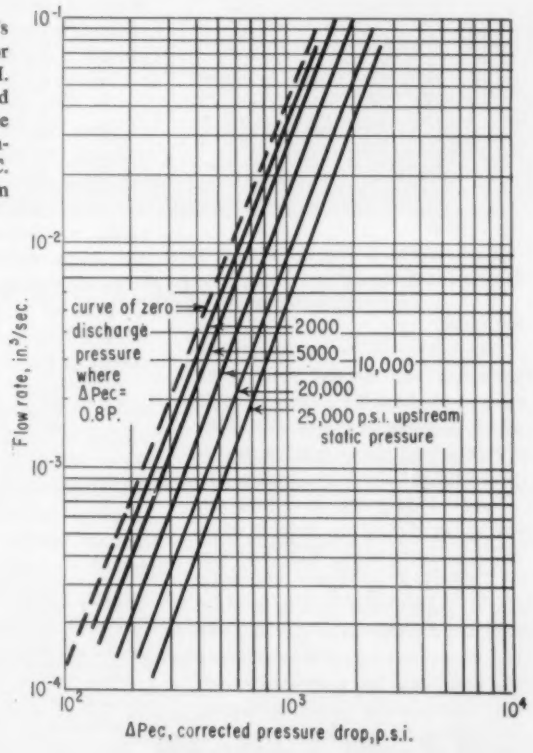

FIG. 5: Westover's data (Reference 2) for 0.92-density, 2.1-M.I. polyethylene, replotted to show flow rate through ⅛-in.-diameter tube at 190° C. and various upstream static pressures.

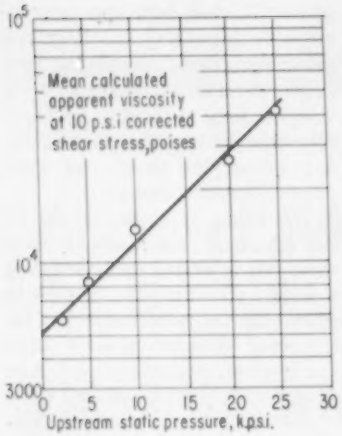
Mean calculated apparent viscosity at 10 p.s.i corrected shear stress, poises
10^5
10^4
3000
0 5 10 15 20 25 30
Upstream static pressure, k.p.s.i.

FIG. 6: Average apparent viscosity at 10 p.s.i. stress and 190° C., calculated from flow rates at 10 p.s.i., shown in smoothed lines in Fig. 5, p. 127, versus upstream static pressure.

tionality exists here, to a close approximation.) We can then write

$$\mu_A = f(\tau_{WC})\, g(P) \qquad \text{Eq. 1}$$

where:

μ_A = apparent viscosity, the quotient of corrected shear stress at wall divided by apparent shear rate at the wall ($4Q/\pi R^3 = 8\bar{V}/D$).

τ_{WC} = corrected shear stress at the wall = $\Delta P\ R/2(L+8R)$. The entrance-loss correction term in the denominator, 8R, is an approximate mean value for polyethylene obtained from the data of Bagley (12) and Metzner (1).

P = upstream static pressure.

Q = volumetric flow rate through the orifice.

R = radius of the orifice; 2R = D, the diameter.

$\bar{V}$ = average velocity of the flowing melt.

ΔP = drop in pressure from the upstream end to the downstream end of the orifice; in a double-piston instrument this would be the difference in the pressures on the piston faces.

Because only one flow tube and one value of τ_{WC} was used in Maxwell's measurements, it is clear that the observed apparent viscosities can vary only with P. Figure 3, p. 125, shows the data of Maxwell and Jung, corrected for entrance loss and based on upstream rather than downstream static pressure, and plotted on semilogarithmic coordinate paper. Eyring's theory predicts that for pressures in the processing range, semilog plots of viscosity versus static pressure should be nearly linear. The data of Fig. 3 fulfills this prediction rather well, though it is difficult to be certain with so few points. The topmost point on the polyethylene plot is significantly above the line because of the pressure-induced crystallization that was mentioned earlier in this article.

Note that since the pressure drop across the orifice was almost 8000 p.s.i. in this work, the highest upstream pressure involved here is about 32,000 p.s.i. for polyethylene and 26,000 p.s.i. for polystyrene. These limits are more than twice the *melt* pressures that might reasonably be encountered in commercial injection molding. Commercial extrusion pressures, generally, are even lower than those met with in injection molding.

Westover's data

In concluding that the effect of pressure on the viscosity of polyethylene was negligible at pressure drops up to 20,000 p.s.i., Metzner and associates (1) dismissed Westover's data with the judgment that "the data obtained using tubes of various diameters scatter greatly instead of giving the perfect agreement required by theory and observed in the present study as well as by many prior workers. As a result their validity and the conclusions drawn [*i.e.*, that there is a significant effect of static pressure on viscosity and flow] are both open to serious question except under conditions where the effects are unusually large, for example, when crystallization was believed to be induced at the lower temperatures." This judgment is not supported by the data.[3]

Westover presented hundreds of points on several materials at a variety of conditions, nearly all of them indicating highly significant differences among the shear stresses required to produce given shear rates at his five different levels of static pressure. The probability that such differences could arise through random combinations of errors is negligibly small.

To test Metzner's assertion that data obtained in tubes of different sizes do not coincide, Westover's 15 sets of data (Fig. 7 of Ref. 2) for a polyethylene of density 0.92 and melt index of 2.1, obtained from Supplier A, were examined. These data were taken at 190° C., using three different tubes having diameters of 0.055, 0.090, and 0.125 in., with lengths 20 times these diameters. For all three tubes, corrected maximum shear stress versus apparent shear rate at the wall for the middle level of hydrostatic pressure, 10,000 p.s.i., has been plotted in the lower curve of Fig. 4, p. 125. All 51 points have been included, and care was taken in estimating their coordinates from Westover's plots. The dashed lines bracketing the central solid curve represent the 95% confidence limits of the data around that curve, which was fitted by eye. These limits are interpreted thus: if we were to con-

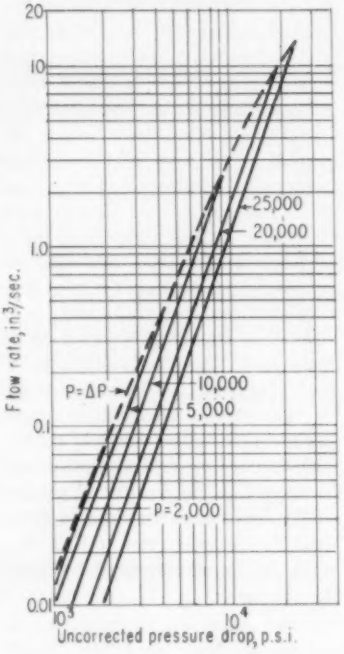

FIG. 7: Extrapolation of Fig. 5 to the region of commercially typical pressure drops. The graph shows that raising pressure in extrusion or injection molding should always result in a sharp rise in the flow rate.

[3] In my opinion, Westover's experimental errors are made to look smaller than they actually are by his practice of connecting pairs of successive data points with segments of straight lines. If smoothed curves are fitted to entire data sets, the true magnitude of the experimental errors becomes clear, and data that he indicated as connected with separate lines seem to cluster around a single line. The six graphs of his Fig. 9, for example, should probably be represented by three graphs. Westover still feels, however, that the separate lines reflect real differences in certain sets of experimental results.

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tinue experimenting exactly as Westover did, we should expect 95% of all the data points for all three tubes to fall within these limits, which are only ±15% from the eye-fitted curve. The fit that could be achieved by more refined fitting methods would not be significantly better.

Metzner *et. al.* have an 88-point plot (Fig. 2 of Ref. 1) similar to that of Westover's data, except that a different resin was tested, the temperature was 160° C., entrance corrections were made by a different equivalent method, and the hydrostatic pressure upstream varied identically with the pressure drop. That curve, because it happens to closely overlap Westover's, is plotted in Fig. 4 a decade above for comparison. (The actual curve covered a wider range than is shown here.) The estimated 95% confidence limits work out to ±18% and are not significantly wider than those for Westover's data. It appears, therefore, that the two sets of data are remarkably comparable with respect to their experimental errors.

Further examination of Westover's data (Fig. 7 of Ref. 2) reveals that the scatter of like plots for the pressure levels 2000 and 5000 p.s.i. would be about equal to this one, but the scatter at 20,000 and 25,000 p.s.i. would be significantly greater unless the data on the 0.090-in. orifice were omitted. This suggests that some unusual source of error was operating in those particular runs. There are further irregularities in his data (Fig. 10 of Ref. 2) indicating that measurements made with the 0.090-in. tube at 25,000 p.s.i. were subject to larger errors than those made at lower pressures or in the other two tubes. With that orifice, there were several plots in which curves obtained at higher pressures crossed over those obtained at lower pressures, implying that viscosity first increased, then decreased with rising static pressure. This is an untenable conclusion.

Practical significance

Granted that the effect of static pressure on flow is real, how important is it to the processor? Maxwell, in commenting on his results, remarked, "It is commonplace for [injection molders] to increase injection pressures in an effort to decrease molding cycles, the thought, of course, being to fill the mold cavities as quickly as possible. As shown by these data, however, a pressure increase will concurrently increase the apparent melt viscosity. Thus the application of higher and higher pressures becomes, in effect, self defeating with no net advantage to the molder."

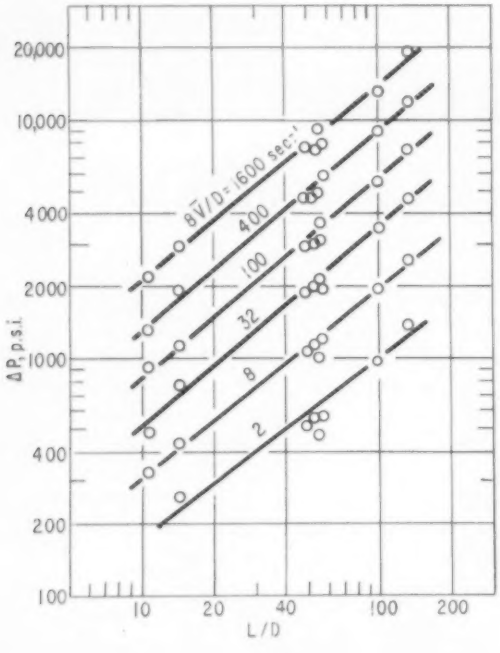

FIG. 8: The data of Metzner *et al.* (Fig. 1 of Ref. 1), showing variation of uncorrected pressure drop with length-to-diameter ratio of orifice at various shear rates, is replotted here logarithmically, to show goodness of fit of data to the hypothesis that static-pressure effect is proportional to two-thirds power of upstream pressure. Original plot of the same data graphed on linear-coordinate paper, also giving good straight lines, was cited as proof of the absence of any effect of the static pressure.

The cost of achieving the higher pressures may be more than can be saved by a resulting slight drop in cycle time. Westover puts it more strongly: "An increase in pressure at the entrance to an extruder die or mold gate *can result in a decrease in flow rate rather than the expected increase* [italics mine] because of the large increase in apparent viscosity with increase in pressure." While Maxwell's conclusion is difficult to test because of the complexity of the cost factors involved, Westover's involves only the question of flow itself, and can be examined in the light of his own data. Westover's data (Fig. 7C of Ref. 2) have been replotted in Fig. 5, p. 127, as smoothed lines giving flow directly in terms of entrance-corrected pressure drop.[4] The five solid lines, representing his data under the given conditions, are so nearly parallel that the average of the observed slopes, 2.67, may conceivably be used for all without any serious error.

If this approximation is made, then the series of ordinates at any chosen pressure drop, if paired with the corresponding static pressures, shows the relationship between flow and static pressure. The same series of ordinates may be used to compute the apparent viscosities corresponding to the chosen shear stress, and since the shear stress is identical for all, the viscosities will be in the same ratios as the flow rates. This was done for the roughly mid-range pressure drop of 800 p.s.i., corresponding in this flow tube to a shear stress of 10 p.s.i., and the resulting apparent viscosities have been plotted in Fig. 6, p. 128, on semi-logarithmic coordinates. The points shown here represent averages of about 20 individual data points, and, since the average flow/pressure-drop slope was used, their relative positions would not change if a different shear stress had been chosen. Note that with all the curve-fitting approximations made in obtaining this plot, the greatest deviation from the line, at P = 10,000 p.s.i., is only 13 percent! The line of Fig. 6 may be extrapolated downward, permitting reading of the apparent viscosities that **(To page 198)**

[4]These lines do not purport to be "best fits" to Westover's data, just reasonably good fits. Also, added error was introduced by ignoring the slight curvature of some of the original graphs. Correction of these fitting errors would not alter the conclusions to follow.

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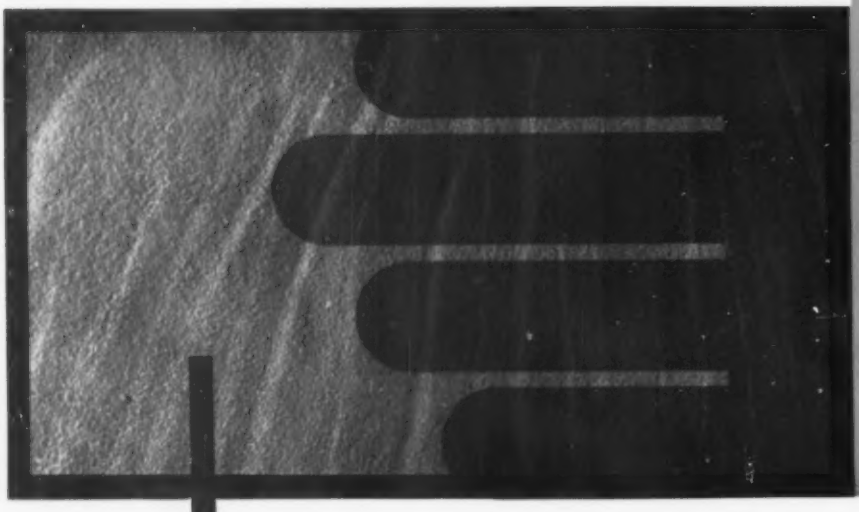

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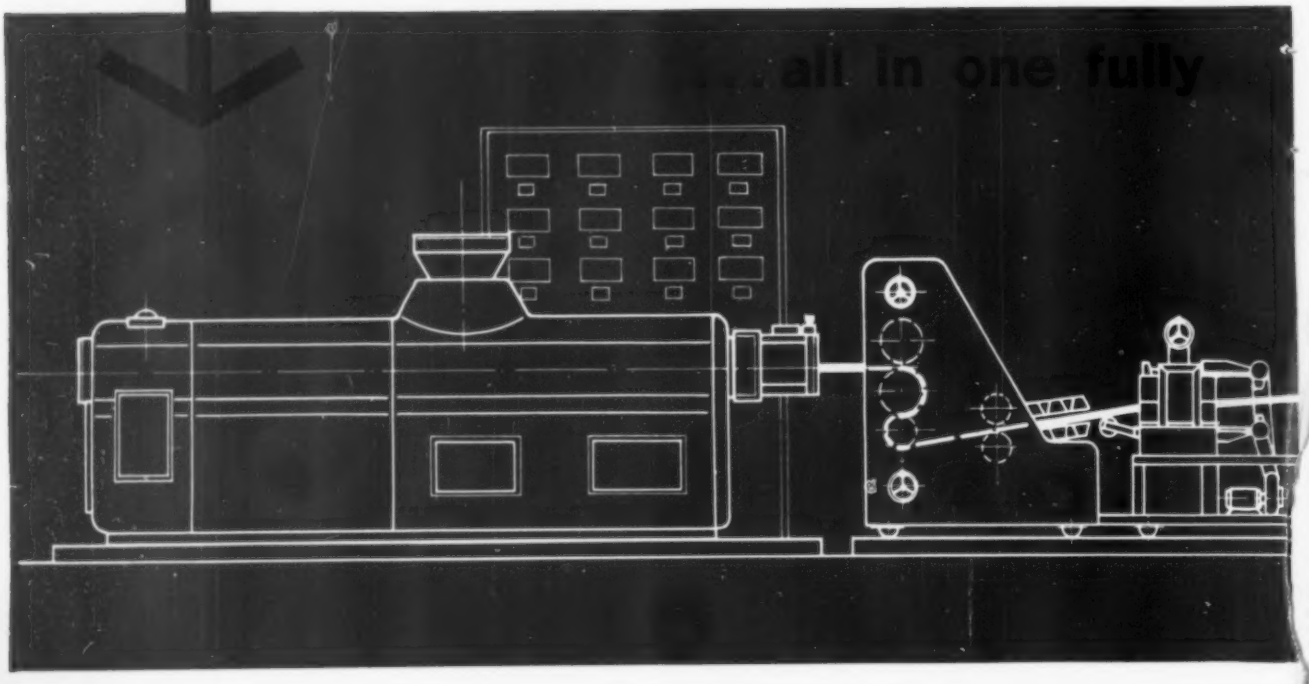

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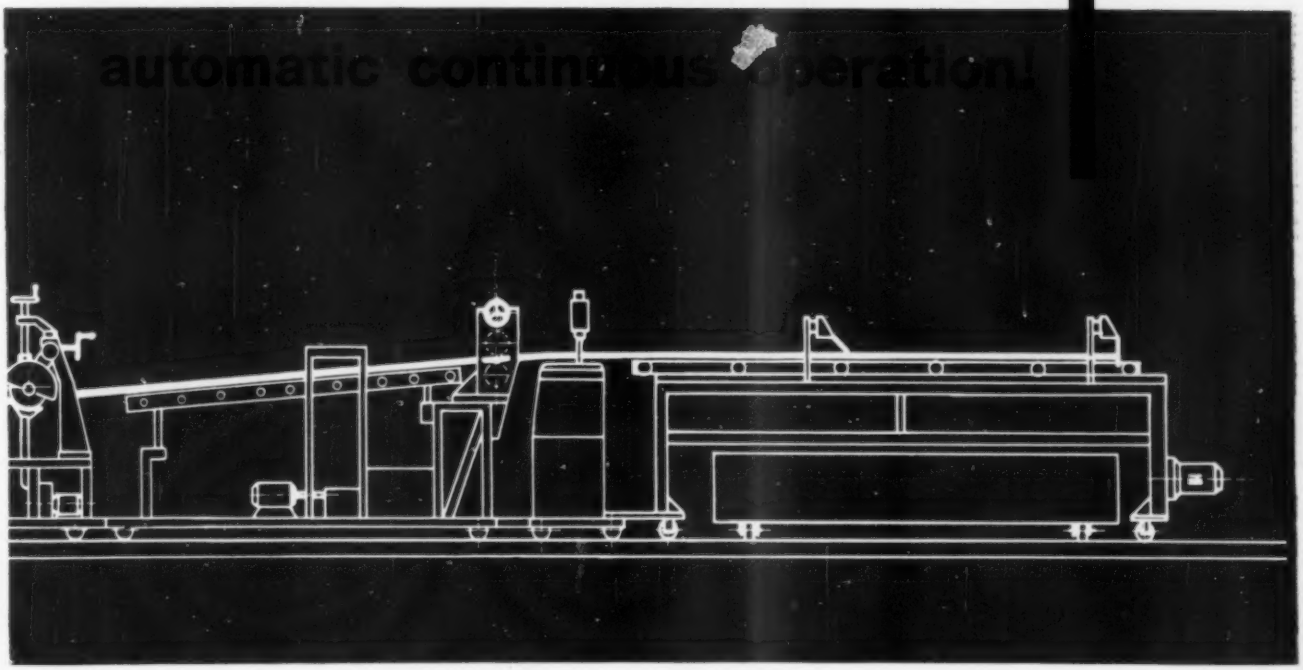

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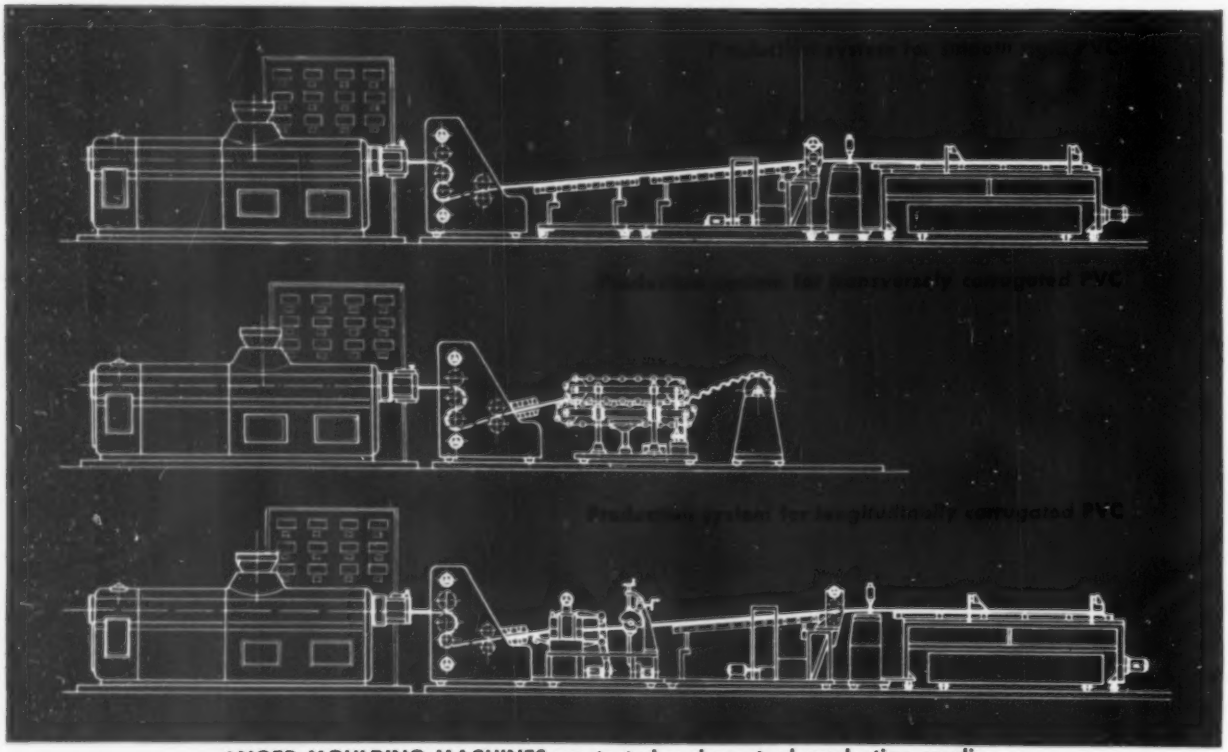

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Furfuryl alcohol as a resin modifier

By Lloyd H. Brown* and E. K. Stigger*

Furfuryl alcohol has two properties that favor its use as a resin modifier. First, it has high solvent power for a wide range of resins and is compatible with many other materials. Second, it is a resin former and can react with many condensation polymers. By reacting with these materials, it can drastically change their properties. This article describes the effect of furfuryl alcohol on the properties of urea-formaldehyde, phenol-formaldehyde, and epoxy resins.

Urea-formaldehyde resins

Furfuryl alcohol is used commercially as a modifier for urea-formaldehyde (UF) adhesives. Simons (1)[1] discloses that furfuryl alcohol imparts gap-filling properties to UF adhesives. These properties are associated with the marked reduction in the crazing tendency of UF resins resulting from the addition of furfuryl alcohol. According to Simons, this effect can be accomplished by the addition of 5 to 50 parts of furfuryl alcohol to 100 parts UF resin (solids basis). If a conventional UF adhesive is catalyzed and cast, it changes overnight to a hard, tough, light-colored resin. On storage for a few weeks it shrinks and crazes until it falls apart. If furfuryl alcohol is added to such an adhesive before it is cast, the casting still may shrink but does not craze on aging. This effect, shown in Fig. 1, p. 138, has a great influence on physical properties and stability attainable in the end-products.

Similarly modified products have been used in abrasive articles (2) where the non-crazing properties are desired. Carlin (3) and Root (4) proposed the use of furfuryl-alcohol-modified UF resins for coatings. Simons (1) suggested their use in molding powders and laminating varnishes.

Furfuryl alcohol improves the relationship between pot life and curing speed of UF resins. When catalyzed and buffered to give equivalent pot life, a UF resin with the addition of 10% furfuryl alcohol cures in about half the time required for the unmodified UF resin (Table I, below, Samples 1 and 4). When catalyzed and buffered for equivalent cure time, the UF resin with 10% furfuryl alcohol has nearly three times the pot life of the unmodified resin (Table I, Samples 1, and 3).

Butanol is frequently etherified with dimethylolurea to give resins with improved compatibilities. During cure, however, the butanol splits out and is volatilized. Furfuryl alcohol, on the other hand, remains as a part of the cured resin solids, thereby contributing to desirable properties.

Modification of UF resins with furfuryl alcohol is opening new doors to progress in core making in the foundry industry (5). These resins have made possible the development of the "hot core box" process for making cores used in casting a variety of metals. In this process, furfuryl-alcohol-modified UF binder (liquid) and catalyst are mixed with core sand. The damp mixture is blown with air pressure into a core box which is maintained at 400 to 500° F. With 2% binder, cores having tensile strengths of 400 p.s.i. or over are obtained using a contact time of 10 to 30 sec. in the box. When **(To page 138)**

Table I: Effect of furfuryl alcohol on pot life and cure speed of urea-formaldehyde resin (Catalin[a] 841)

Sample No.	*Resin*	*Furfuryl alcohol*	*29% NH_4OH*	*25% NH_4Cl*	*Pot life*	*Cure time at 100° C.*
	g.	*g.*	*g.*	*g.*	*hr.*	*sec.*
1	150	0	4	4	27	80
2	150	15	4	4	168	97
3	150	15	3	4	68	72
4	150	15	2	4	27	42
5	150	15	1	4	3	25

[a]Tradename of Catalin Corp. of America.

Table II: Electrical properties of furfuryl-alcohol modified epoxy resin

Property	*Parts furfuryl alcohol/100 parts Epon[a] 828*		
	0	*10*	*20*
Dielectric constant (ASTM D 150-54T)			
At 10^3 cycles	4.3	4.3	4.3
At 10^6 cycles	4.3	3.6	4.4
Dissipation (power) factor (ASTM D 150-54T)			
At 10^3 cycles	0.0048	0.0045	0.0037
At 10^6 cycles	0.0244	0.0266	0.0247
Volume resistivity[b] (ASTM D 257-58), 10^{14} ohm/cm.	1.6	1.4	1.3
Dielectric strength (ASTM D 149-55T) at 30 kv., v./mil.	380	380	290

[a]Tradename of Shell Chemical Co. [b]The test specimens were conditioned at 50° C. and 50% relative humidity.

*The Quaker Oats Co.
[1]Numbers in parentheses designate references at end of article, p. 206.

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Whatever the "must," Pro-fax invariably also provides the *most* in a modern construction material. Lightest of all plastics, it yields the most plastic product per pound. Its many innate plus features, in terms of properties, processability and cost, always add up to big value in functionality... merchandising appeal . . and consumer satisfaction.

Pro-fax is in the picture when heat resistance is a "must"

Resistance to heat from the projector light made Pro-fax a "must" for "Duojector." This new magnifier-projector for slides, artwork, photos, coins and stamps has a host of other plus features thanks to Pro-fax: compact, attractively styled, readily portable—since it's made with the lightest of all plastics—Duojector is virtually unbreakable, with a rich, colorful finish that is immune to staining and will withstand both use and abuse.

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Pro-fax hinges dispense with assembly costs

Pro-fax was a "must" in this unique dispenser-package for Permacel's RIBBON DOPE* Thread Sealant, a new sealer designed for use on threaded pipe joints. Four integrally molded hinges are combined in a single molded part which opens to accommodate a roll of RIBBON DOPE, then folds and locks together to make a lightweight compact carrier. A snap-in blade cuts tape to any desired length, and the handy unit can be tucked in pocket or tool box, stored in any convenient place, or kept available on the worktable. When product success hinges on functionality plus low cost, Pro-fax provides the *most* plastic for the job.

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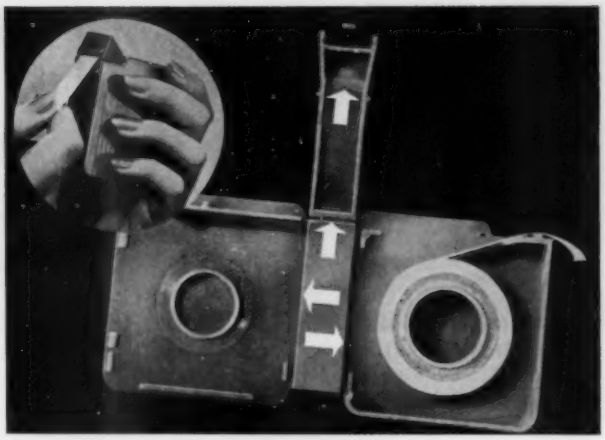
Molded by Pyro Plastics Corp., Union, N. J., for Permacel, New Brunswick, N. J.



DOMINION makes a case for Pro-fax in portable home appliances

All of the advantages of Pro-fax which make it ideal for luggage—light weight, resilience, resistance to scuffing and staining—were needed in the case for Dominion Electric's new hair dryer. But UL listing was required, too. Dominion achieved this by the use of an intumescent coating, applied to the interior surface of this handsome injection-molded carrier. Result: A revolutionary new appliance, a veritable portable beauty salon, easily moved, usable anywhere.

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Many "musts" make Pro-fax the most

The combination of properties available in Pro-fax made this radical new concept in laboratory equipment a reality. Six of these molded "drawers," each holding nine culture tubes, nest in a compact case which permits handling 54 tubes at one time. They replace a cumbersome metal rack which required individual handling of each tube under the microscope and during subsequent cleaning and sterilizing. Pro-fax was a "must" for the resilient retainer rings which anchor test tubes firmly in place so that a full drawer can be studied, washed, and steam-autoclaved without removal. Pro-fax was a "must," too, for the built-in hinge catch on each drawer, designed to hold it in the six-drawer case. All these many "musts" have made Pro-fax the *most* plastic for a variety of new laboratory-ware applications, including test tubes, beakers, and a number of measuring devices.

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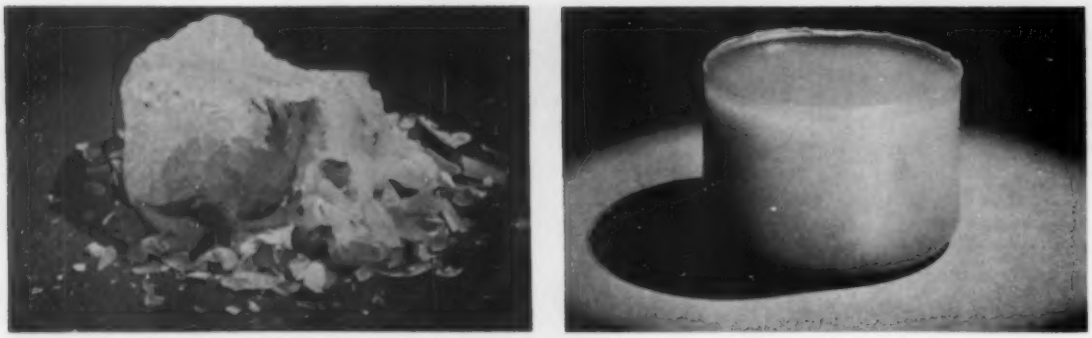


FIG. 1: Effect of furfuryl alcohol on craze resistance of urea-formaldehyde resin. (Left): Unmodified UF resin. (Right): Furfuryl-alcohol modified UF resin.

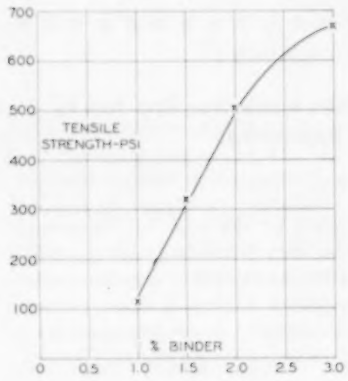
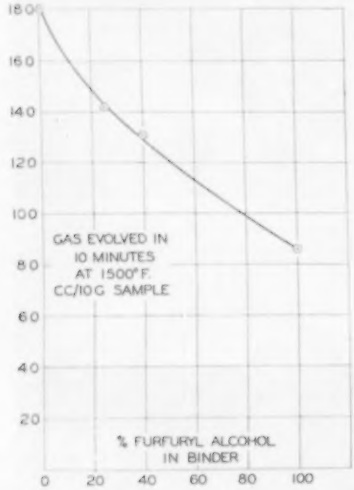


FIG. 2, above: Tensile strength of cores bonded with furfuryl-alcohol-modified UF resin binder as a function of binder content. Mol ratio of formaldehyde to urea was 2:1; furfuryl alcohol content was 30% based on total resin solids.

FIG. 3, below: Gas evolution from core sand containing 2% binder as a function of the furfuryl alcohol content of the modified UF binder. Mol ratio of formaldehyde to urea was 2.5:1.



ejected from the box after this short period of time, the core is sufficiently strong to withstand normal handling in the foundry. The core may not be cured completely through; however, the soft center cures and full strength is attained by the time the core has cooled. Figure 2, left, presents the tensile strength of cores made from mixes containing varying quantities of such resins on Ottawa silica sand of AFS 75-grain size. The data were obtained on 1-in.-thick "dog-bone" tensile specimens formed by ramming and then baking at 425° F. to optimum strength.

Urea-formaldehyde resins have been mixed with cereal binders, such as pregelatinized corn flour, to prepare foundry core binders. These binders are baked in the same manner as conventional cereal-oil cores or cured by dielectric heating. Their use has been limited to uses in which hot strength is not required. Unmodified UF resins are not satisfactory for use in the hot core box process for making cores. The properties of UF resins that limit their use in foundry applications are discussed below along with the effect of furfuryl alcohol on these properties.

Gas evolution from a furfuryl-alcohol-modified UF resin is lower than that for conventional UF resin at metal pouring temperatures (Fig. 3, left). As demonstrated in Fig. 4, right, UF resins completely pyrolyze at metal-pouring temperatures, whereas furfuryl alcohol resins leave a carbon residue. The sand that is pictured at the top of Fig. 4 was bonded with 2% of an unmodified UF resin, and subsequently pyrolyzed at 1500° F. The sand shown at the bottom was bonded with 2% of a furfuryl alcohol polymer and pyrolyzed under the same conditions. The dark color is evidence of carbon left by the furfuryl alcohol resin.

In addition to its effect on gas evolution, furfuryl alcohol has a pronounced effect on hot strength (Fig. 5, p. 140). These data are based on hot compressive strength measurements obtained in a dilatometer after 12 min. at 2500° F. Test specimens were 1⅛ in. in diameter by 2 in. in height. This

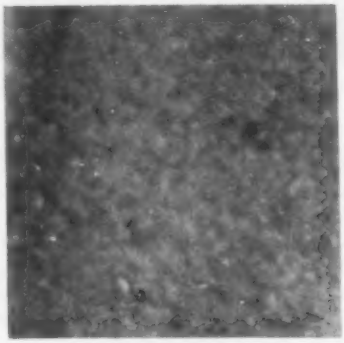
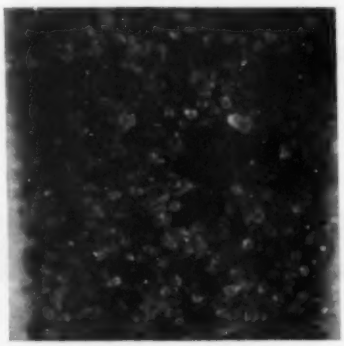


FIG. 4: Effect of pyrolysis at 1500° F. on resin-sand mixes. (Top): UF resin; (Below): Furfuryl alcohol resin.



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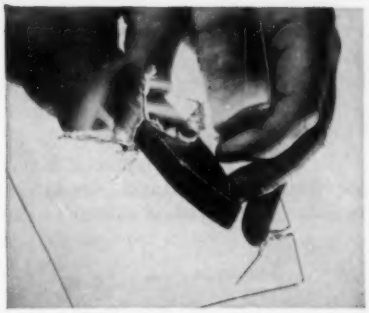

COMPARE—Rough treatment produces a spider-web of rips in gelatin-like sheets cast from ordinary flexible resins. But tough, firm Q-6030 elongates without either ripping or shattering.

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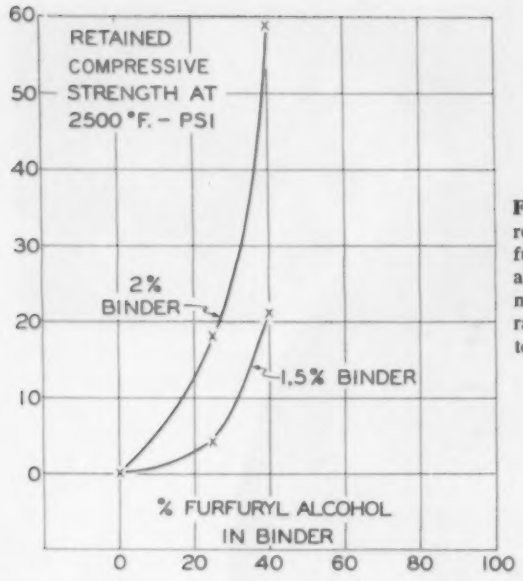


FIG. 5: Hot strength of resin-bonded sand as a function of the furfuryl alcohol content of a modified UF resin. Mol ratio of formaldehyde to urea was 2.5:1.

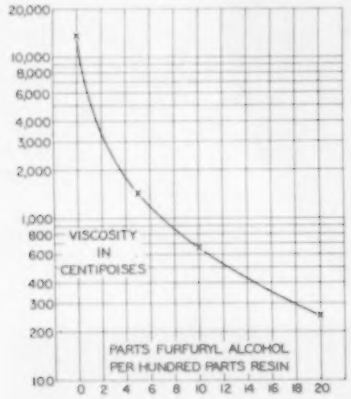


FIG. 6: Viscosity of Epon 828 as a function of furfuryl alcohol addition.

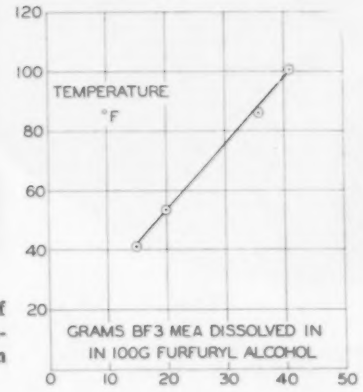


FIG. 7: Solubility of boron trifluoride-monoethylamine complex in furfuryl alcohol.

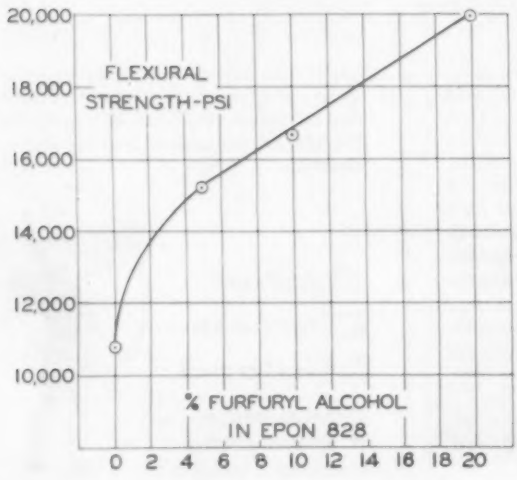


FIG. 8: Effect of furfuryl alcohol on flexural strength of epoxy resin castings.

property makes possible the application of these resins to the pouring of a wide variety of metals, from aluminum to steel. This has not been possible with conventional UF resins, because the resin bond tends to collapse too rapidly at high metal-pouring temperatures.

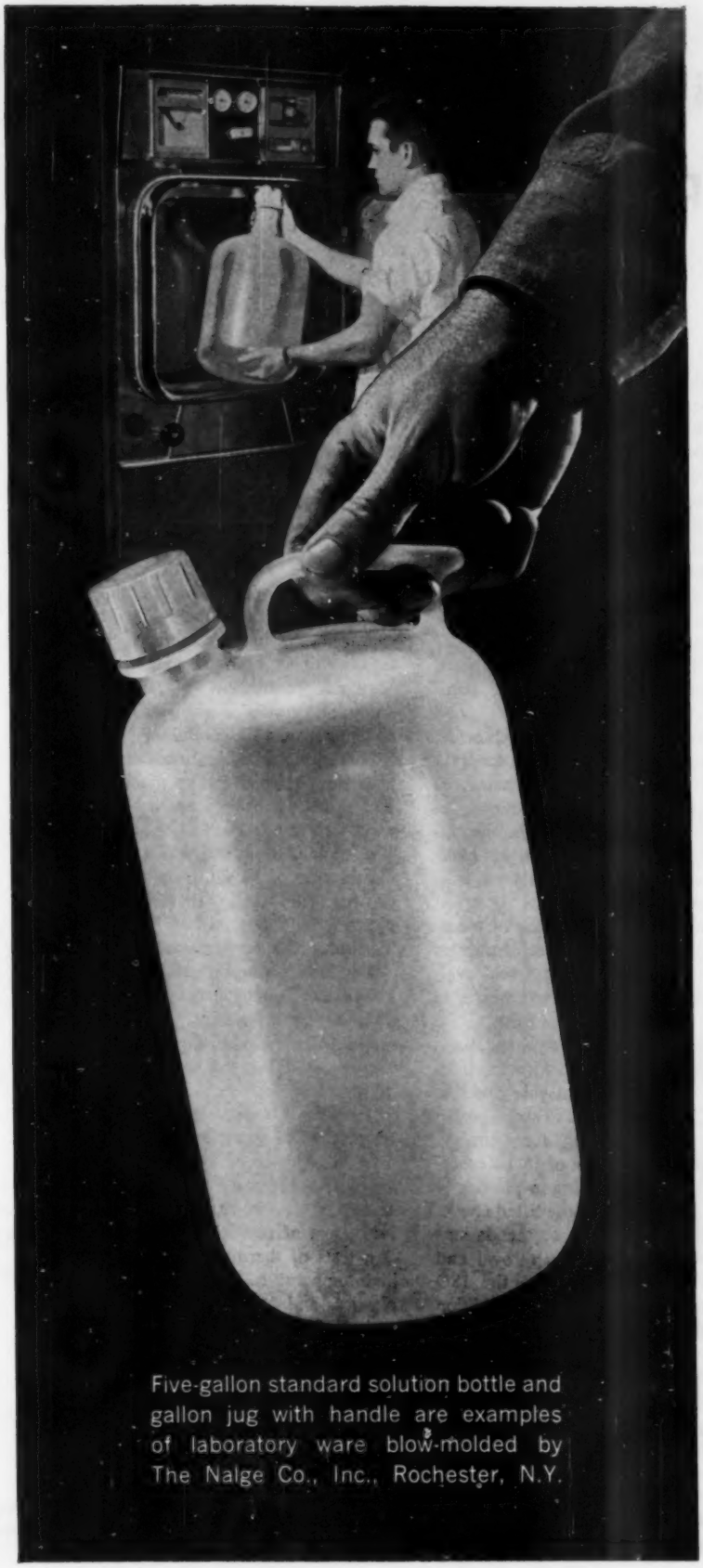
Urea-formaldehyde resins of the type used in adhesives or with cereal binders for foundry work are produced at 40 to 65% solids, the balance being water. Furfuryl-alcohol-modified UF resins of the type being used in the hot core box process for foundry cores can be prepared at much higher solids content. This minimizes possible danger from casting molten metal against a core that may not have been sufficiently dried prior to use.

Present progress in the hot core box method of making cores using furfuryl-alcohol-modified UF resins indicates that this technique will not only compete with conventional cereal-oil core making techniques, but also will be competitive in many cases with shell-molding techniques utilizing phenolic resins. Using 2% of a furfuryl-alcohol-modified UF resin, cores can be made with strength equivalent to shell cores using 3% of a phenolic binder.

Phenol-formaldehyde resins

Furfuryl alcohol has been used for many years to wet the grains of abrasive wheels before addition of phenolic resin which supplies the bond. It is generally agreed that furfuryl alcohol improves adhesion of the resin, and it has been demonstrated that up to 20 parts of furfuryl alcohol per 100 parts of resin can be reacted in good yield.

Various methods have been proposed for reacting furfuryl alcohol with phenolic resins. Lebach (6) proposed simple mixing of furfuryl alcohol polymers with one-stage phenolic resins and curing the resulting solutions with acids. Dunlop and Reineck (7) condensed furfuryl alcohol, or its polymers, with a phenol. Their products were viscous liquids which cured with hexamethylenetetramine. Korten (8) described a similar product, but used an acid catalyst for the condensation instead of the high temperatures used by Dunlop and Reineck. Brown, Watson, and Siegfried (9) reacted furfuryl alcohol with phenolic novolaks to **(To page 206)**



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SPECIAL REPORT:

Eleventh meeting of ISO/TC 61 committee on plastics

Oct. 2-7, 1961, Turin, Italy

The 11th meeting of the Technical Committee 61 on Plastics of the International Standardization Organization was held in Turin, Italy on Oct. 2-7, 1961. Sixteen countries were represented by 126 delegates and observers as follows: Belgium, 1; Czechoslovakia, 3; France, 17; Germany, 13; Hungary, 2; Italy, 24; Japan, 7; Netherlands, 7; Poland, 2; Rumania, 2; Sweden, 8; Switzerland, 11; United Kingdom, 11; United States, 12; U. S. S. R., 4; Yugoslavia, 2.

The U.S. delegation, appointed by the American Standards Assn., consisted of A. C. Webber, Leader (Du Pont); Robert Burns, Chairman of the 11th meeting (Materials Advisory Board, National Research Council); C. L. Condit, Secy. (S.P.I.); W. E. Brown (Dow Chemical); H. W. Dailey (American Standards Assn.); H. C. Gunst (Union Carbide Plastics); E. A. Hafner (Naugatuck Chemical); J. B. Howard (Bell Telephone Labs.); G. W. Ingle (Monsanto Chemical); G. M. Kline (National Bureau of Standards); N. A. Skow (Synthane Corp.); and S. Steingiser (Mobay).

The 10 Working Groups held 19 sessions and discussed approximately 50 of the items currently listed on the ISO/TC 61 agenda.

Four Draft ISO Recommendations were revised editorially and are now ready for submission to the ISO Council for approval and publication. These documents concern determination of thermal stability of polyvinyl chloride and related copolymers and their compounds by the discoloration method; Vicat softening point; viscosity number of polyamide resins in dilute solution; and acetone-soluble matter of phenolic molding materials.

Three new Draft ISO Recommendations were approved for circulation to the 44 ISO Member Bodies for a letter ballot vote. These relate to testing of plastics with the torsion pendulum; relative viscosity of polyamide resins in concentrated solution; percentage of monomer and low molecular weight polymer in polyamide resins; and change of mechanical properties after contact with chemical substances.

Six Draft Proposals were prepared for consideration by the 21 ISO/TC 61 Members. They concern definitions for rigid plastic, semi-rigid plastic, non-rigid plastic, and unplasticized polyvinyl chloride; methods for maintaining constant relative humidity in small enclosures by means of aqueous solutions; revision of Draft ISO Recommendation 317, determination of melt-flow index of polyethylene and polyethylene compounds; determination of refractive index of transparent plastics; resistance of plastics to moulds (mildew) by visual evaluation; and resistance to changes in color caused by natural light.

Thirteen ISO Recommendations prepared by ISO/TC 61 were published during the past year and one (List of Equivalent Terms) is in page proof reading for printing. This brings the total of ISO Recommendations pertaining to plastics to 23. In addition to those listed above, five Draft ISO Recommendations are awaiting Council approval and three have been sent to the ISO General Secretariat for circulation to ISO Member Bodies, making a total of 45 preliminary or final international standards on plastics prepared by ISO/TC 61.

Progress of 10 working groups

Working Group 1 on Nomenclature and Definitions agreed on a list of some 200 supplementary terms to be prepared in English, French, and Russian, and circulated to its members. This group is also drafting abbreviations and definitions for plastics terms.

Working Group 2 on Mechanical Properties has prepared drafts of methods for the determination of compressive properties of plastics and tensile properties of thin films for circulation to its members. The group is considering methods for tensile impact strength, indentation hardness, coefficient of friction, creep, and modulus of elasticity by the alternating pendulum test. Preparation of international standards for universal testing machines and statistical procedures is under way. A revision of Draft ISO Recommendation DR 468 for determination of tensile properties to provide for testing thermosetting plastics and materials of high extensibility is in preparation.

Working Group 3 on Standard Laboratory Atmospheres and Conditioning Procedures is considering methods for measuring relative humidity as well as for conditioning of polyamides.

Working Group 4 on Thermal Properties has work under way on melt flow index of polypropylene, flow of thermoplastic and thermosetting materials, low-temperature brittleness of plastics, hot penetration tests of thermosetting plastics, high-temperature deformation of plastics, and flammability determination. The group reported that glycerol, glycol, mineral oil, and silicone oil had been found to be satisfactory heat transfer media for the determination of Vicat softening point of polyvinyl chloride.

Working Group 5 on Physical-Chemical Properties has task groups working on the determination of chlorine in vinyl chloride polymers

and copolymers, vinyl acetate in vinyl chloride/acetate copolymers, optical properties of plastics, permeability, properties of polyolefin and cellulose acetate plastics, water content of polyamides, viscosity of polyethylene terephthalate and polymethyl methacrylate, density by the gradient tube method, and a revision of ISO Recommendation R 62 on water absorption of plastics. A revision of the scope of the latter standard was accepted by the members of ISO/TC 61.

Working Group 6 on Aging, Chemical, and Environmental Resistance is reviewing drafts of methods for determination of resistance of plastics to natural light and to artificial light (carbon arc and xenon lamp). Task groups from the Committee are currently working on stress cracking of polyethylene, loss of plasticizer in ventilated ovens, and thermal stability of polyvinyl chloride.

Working Group 7 on Preparation of Test Specimens is undertaking the standardization of molds for test specimens of thermoplastic and thermosetting materials, and procedures for machining and casting of such specimens.

Working Group 8 on Electrical Properties considered and commented on various documents prepared by IEC/TC 15 on measurement of electrical properties. ISO/TC 61 accepted the group's recommendations that the scope of W. G. 8 include the development of electrical tests for the evaluation of physical and chemical properties of plastics materials and that liaison be established with IEC/TC 52 on Printed Circuits.

Working Group 9 on Specifications considered proposals for properties to be included in standards for phenolic molding materials, phenolic industrial sheet laminates, and polyvinyl chloride resins and rigid plastics. Task groups were organized in Turin to work on specifications for decorative laminates as well as for polyethylene.

Working Group 10 on Cellular Materials held its first meeting at Turin. It defined its scope as "methods of test, nomenclature, and specifications for cellular plastics materials," and established task groups on 1) nomenclature, 2) density and mechanical properties, and 3) thermal properties and water absorption. Work will commence on rigid cellular plastics with first priority to be given to the standardization of compressive as well as flexural strength tests.

The 1962 meeting of ISO/TC 61 will be held in Warsaw, Poland, Sept. 17-22. It will be preceded by the 4th Annual Symposium on "Polymer Research" to be held under the auspices of the Committee for Chemistry and Technology, Polish Academy of Sciences, at the Technical Universtiy of Lodz, Sept. 13-15. Abstracts of proposed papers should be submitted by Feb. 1, and manuscripts should be turned in by July 1, 1962.

It is tentatively planned that the 1963 meeting of ISO/TC 61 will be held in London in June, immediately following the biennial British Plastics Exposition that is scheduled for June 10-23 and preceding the proposed IUPAC Macromolecular Commission Symposium that is to be held in Paris on or about July 12-16, 1963.—**End**

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S.P.I. New England Section Conference

The 17th Conference of the New England Section of S.P.I. was held Oct. 12-13, as usual, at Wentworth-by-the-Sea, Portsmouth, N.H. Theme of the sessions was "Creativity in Marketing."

Chairman of the Oct. 12 conference was Kenneth L. MacIsaac, Monsanto Chemical Co. First speaker was E. M. Osgood, American Radiator & Standard Sanitary Corp., who showed how his company developed markets for superior toilet seats and then expanded and diversified into trays, furniture elements, and other items which fitted into their manufacturing and marketing facilities.

Pinch-hitting for John R. Ansley was Carl Setterstrom, General Sales Manager, Chemicals Division, Rexall Drug & Chemical. Mr. Setterstrom made a masterful analytical presentation on selection of product lines for profit as related to volume.

Dr. R. L. Purvin, Vice-President, Foster Grant Co. Inc., discussed the importance of a sales philosophy related to the creation of profits and emphasized the "plus" values or assets which are part of every company's story, but are frequently not stressed in selling.

C. Wm. Cleworth, Publisher, *Plastics World*, described his most recent trip to the shows in Europe, and discussed the trends he noted.

The session on Oct 13 was under the chairmanship of John W. LaBelle, Foster Grant Co. Inc. Leading speaker was Walter F. Oelman, President of S.P.I., who gave the conference a well-detailed capsule picture of the structure and operations of the Society.

Dr. Calvin Dolan, manager of plastics development, Missile & Space Development Dept., General Electric Co., substituted for Dr. I. J. Gruntfest in a discussion on plastics in the space age. He spoke of time-temperature relationships in the new satellite and missile materials, pointed up the importance of further rapid development of high-heat resistance and radiation resistance, and showed a most exciting motion picture of a modern filament winding operation for space vehicle use.

Final speaker was Hiram McCann, Editor-in-Chief, MODERN PLASTICS, who took as his theme "Management Creativity for Profit." Mr. McCann analyzed marketing trends in plastics over the past few years at all levels of the industry, showing that, while we are ever making and selling more plastics, we are far from maintaining a decent profit position. He offered suggestions for improving the picture, and pointed out that, as businessmen, we are in the business of making money; plastic is our vehicle.

The Toastmaster for the annual informal dinner was Anthony P. Beaudry, Reed Plastics Corp.

Danish International Plastics Fair

Denmark's first International Plastics Fair was held in Copenhagen, Sept. 22 to Oct. 1. Its purposes, aside from the usual one of engendering sales, were twofold: to promote plastics in general to the citizens of Denmark and to show to the rest of Europe, on the eve of Denmark's application to join the Common Market, just what the Danes could do in this segment of the Continental economy.

About 300 companies make up the Danish plastics industry. Most of them are processing firms. One field that seems to be making progress rapidly is acrylic sheet extrusion—five or six companies are competing in international markets.

More than 220 companies, representing most of Western Europe, the United Kingdom, and the United States, exhibited at the fair. The results: nearly 100,000 visitors to the exhibition hall, and an estimated $14 million in sales.

While Copenhagen's trade fair was not a large one in terms of the ones at Düsseldorf, London, or New York, there were exhibits worthy of interest.

In equipment, most of what was new was new mostly to the Danish public, and they were treated to a number of demonstrations of injection and blow molding. Among Danish equipment, a hopper-dryer-materials-feeding system by Continator I/S drew attention.

One interesting demonstration was of blow molding a pressurized polyethylene toy ball. In this technique, the hole left by the extraction of the blow needle was welded by a separate piston while the PE was still hot.

Screw-preplasticating injection machines were major attractions, as they have been at recent shows. Netstal A.G., Switzerland, showed its Rotomat machines featuring screw preplastication with piston injection; Akesson Bros. showed a screw-preplasticating machine with two pistons; these could be used in single-stroke or alternating-stroke operation. Among the applications on display, industrial containers made by the Engel process from powdered PE got a lot of attention —especially the 8000-liter (1055-gal.) one hung from the ceiling of the hall. These were made by Plast AB Cipax, Norway, who also exhibited a one-piece PE bathroom.

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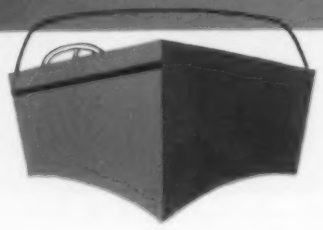

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was some black polyethylene sheeting 4 meters (15 ft., 9 in.) wide.

An inflatable "house"—a tent-like structure of PVC-coated nylon cloth—was exhibited by A/S A.P. Boltved, Norway. It got a lot of attention, because the Danes, too, have difficulty in building during the winter.

Building got a fair share of attention with displays of colored corrugated PVC roofing sheet, available in rolls of 130-ft. long, and even rain gutters and spouts of the same material.

An injection-molded helmet liner now in use by the Danish and Norwegian armies was made of nylon 6 by Dansk Kunststof Industri.

Plastics Show of Canada

At the Canadian National Exhibition grounds in Toronto, Canada, Oct. 17-19, was staged Canada's first plastics show.

For an initial effort, this show was very good. Its locale provided for adequate isle space between the 138 exhibits. It was colorful, well-lighted, and well-serviced.

For those who attended the National Plastics Show in New York and the British Interplas Show in London in June, there was little shown that was new. It was observed that the equipment exhibited was not generally as fully automatic as that shown in New York, possibly because the population of Canada is still less than 20 million, and automation may not be required to the same extent as in the United States. An example is in the reinforced plastics field where hand layup is still the favorite method of molding.

A number of European machines of all kinds were exhibited by their Canadian representatives, but the materials exhibited were generally of American origin.

One outstanding exhibit was that of the Association of Canadian Industrial Designers, with actual plastic products, photographs, and drawings to illustrate distinctively Canadian designs in plastics.

While there was no sponsorship of the show by S.P.I. or S.P.E. in Canada, two dinners were held by the societies, attended by their international leaders.—**End**

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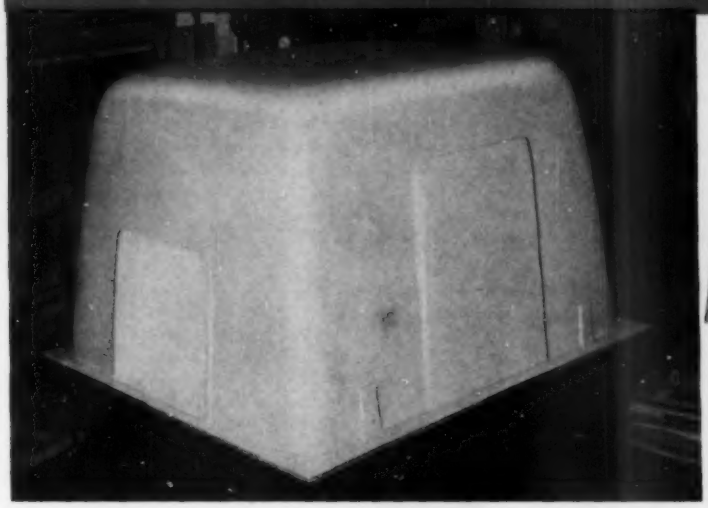
NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.



Thermoformed ABS sheet in mobile housing

Large camper tops, vacuum formed of expanded acrylonitrile-butadiene-styrene (ABS) sheet, will convert Ford Econoline pickup trucks into mobile living and sleeping quarters. Two tops are offered: one with 59 in. headroom, the other with 74 inches. Only four bolts are required to fasten a camper top to the rear body of the truck.

The structural material for each top consists of an expanded ABS core, faced on both sides with two plies of ABS sheet. This 5-ply material, which has also been used for boat hulls, offers high impact resistance, shock- and sound-absorbing characteristics, resistance to rust and corrosion, and integral color. The expanded ABS sheet is said to be lighter, less brittle, and easier to repair than other materials used for this application. If a camper top is dented, it can be restored to original shape by applying hot air to the dented area.

Expanded (ABS) material is supplied by U.S. Rubber Co., Royalite Div., Chicago, Ill., and formed into camper top shells by the parent company's Footwear & General Products Div., Mishawaka, Ind. A reverse-bubble forming technique is used, and the manufacturer states that the bigger of the two tops represents the largest structure (weight: 115 lb., height: 53 in.) ever formed by this method. After they are formed, the camper top shells are die-cut to provide for window and door openings.

The conversion units are now being offered through Ford's dealer network throughout the United States as optional equipment. List price is $468 for the standard top, and $514 for the bigger model.

Non-combustible urea for fire extinguisher

Conical urea components in a new line of fire extinguishing units add a touch of fashion decor to an otherwise non-glamorous product. The extinguishers are produced by Precision Automatic Fire Equipment Inc., Indianapolis, Ind.

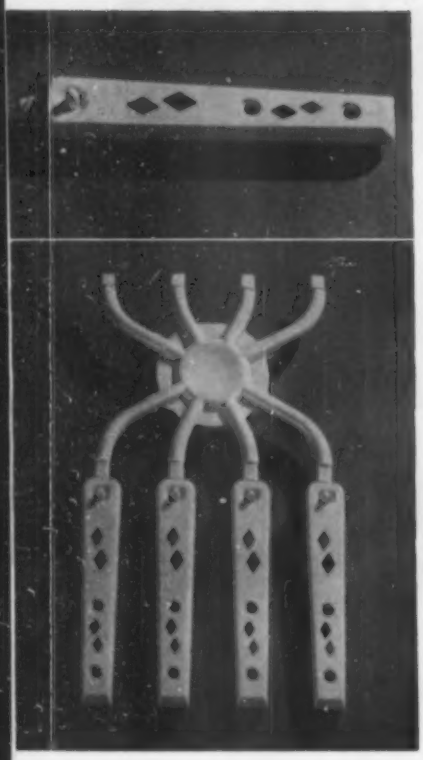
The urea part (colored in photo) is a molding into which is fitted a glass grenade housing a halogenated fire-extinguishing fluid. When the heat of a fire rises to 160° F., a fuse, located at the tip of the urea cone, opens to trigger a spring-loaded smasher slug. This slug breaks the glass grenade and releases the compound into the cone, from where it is sprayed out through small holes. Since the compound boils at 150° F., it is vaporized into an effective fire-dousing fog by the fire.

In addition to non-burning characteristics, selection of urea for the cone part was based on its good colorability, since the units must be attractive enough to blend with the decor in homes and offices. Colors available are ivory, light gray, and iridescent tan.

The cones are compression molded on a 75-ton press by Pribble Plastics Products Inc., New Haven, Ind. Molds are single-cavity, steam-heated, and feature top ejection. Urea molding powder, UFR-28, is supplied by Allied Chemical Corp.

Price ranges from $9.95 for wall-mounted units to $15.95 for ceiling-suspended extinguishers.

(More Developments on p. 150)



Foil decorating for production economies

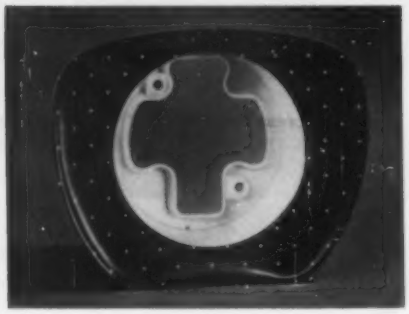
Evidence continues to accumulate that molders of thermosets can effect significant savings by decorating their products right in the mold with resin-impregnated foil. Some outstanding industrial examples were described in "New approach to industrial marking: molded-in foils," (MPI, Nov. 1961, p. 88). Here are two recent British applications of this decorative technique to consumer products.

Clock housing (below) molded by Viking Industrial Plastics Ltd., for Smith Clock & Watches Ltd.

In this application, four different clock case face designs were produced from the identical mold. In addition, two faces are produced in solid color by the foiling process. These are relatively short runs, and, by going to foils, the molder was able to avoid the expense of maintaining an inventory of colored molding powders or of compounding colored material. By foiling, the clock case face can be changed from one design to another without any machine down time.

Stainless steel kitchen tools, Skyline Smart Set (left), by Prestige Group Ltd., with Melmex melamine handles.

These handles, decorated with foils by Streetly Mfg. Co. Ltd., represent one of the finest examples of the foil technique to-date. The handles are molded and decorated in an eight-cavity transfer mold, modified for foil molding. As in the case of the clock, a simple change in the foil would permit a completely different design, without change in tooling or molding material.



The result is a beautiful handle which is a far cry from the appearance of the usual monotone utensil.

Decorated foils are made and supplied by Ornamin (U. K.) Ltd., Northampton, England.

Switch from steel to acetal saves 95.5%

This startling cost reduction was achieved by Production Enterprises Inc., Hialeah, Fla., through a redesign in the support bearings for a line of photocopying machines. The machines are produced by Statmaster Corp., under the names of Filmostat and Modiflex.

Requiring extreme accuracy at all positions of three movable platforms, Statmaster in the past specified a special all-metal double-row ball bearing at approximately $12.14 per bearing. Each machine uses 12 bearings.

A new part has now been engineered, utilizing two economical radial-thrust ball bearings with a specially designed outer tire of acetal. Cost of the redesigned bearing is $0.543 each. In addition to this initial cost saving, the switch to acetal gave two additional advantages: quieter operation and elimination of previous maintenance problems resulting from metal-to-metal contact.

The wheels are produced in a single cavity fitted into a family mold using side gating of 0.050 by 0.20 in. (for a cross-section of 0.01 in.). Piece weight is 13.5 g. (a little less than ½ oz.) and cycle time is 55 seconds. The part is annealed in mineral oil for 30 min. at 320° F.

In another metal-to-acetal switch reported by the company, steel ball bearings for rolling patio doors, costing about 20¢ each, were replaced by acetal-tired ball-bearing wheels at 16½ cents. As in the case of the photocopy machine bearings, the switch resulted in smoother, quieter, and maintenance-free operation.

The door bearings are produced in a six-cavity, cam-operated mold, operating on a ½-min. cycle. Slides are changed for different sizes and shapes of tires, and pins are changeable in order to accommodate different widths of bearings.

Acetal parts are molded for Production Enterprises by Industrial Plastic Molders Inc., Hialeah, using Du Pont's Delrin. **(More on page 153)**

ACETAL TIRE (right) is used on new design for bearings of movable platforms of photocopying machines. Mold (below) is used in making of another acetal tire for bearings of sliding patio doors. Acetal replaced steel in both instances at high savings.

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See the chart below for more data on MPE 70. For further information, write Monsanto Chemical Company, Plastics Division, Room 832, Springfield 2, Massachusetts.

MPE 70 PERFORMANCE DATA

PROPERTY	TEST METHOD	UNITS	AVERAGE VALUES
BASIC Specific Gravity	ASTM D 792-50	---	0.918
THERMAL Melt Index	ASTM D1238-52T	gms/10 min.	5.0
PERMEABILITY (1 mil MPE 70/ 1 mil M Film) Moisture Vapor Transmission (100°F, 95% R.H.)	ASTM E 96-53T	gms./24 hrs./ 100 in. 2	.77
PROCESSING Recommended Extrusion Coating Temperature Range		°F	560-600°F
Neck down @ 600°F, 24" Die, 4" die-nip			1¾" Total
Minimum Drawdown @ 600°F			5#/ream (0.35 mil)
Aged adhesion on M cellophane			1300 gm/inch

Details of Monsanto Tests available upon request.

MONSANTO

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Disposable bulk milk container

A double-layer polyethylene (PE) film bag liner inside a collapsible heavy-duty kraft paperboard container is now being marketed to dairies as a replacement for conventional metal cans. Claims: savings in weight, space, and cost.

The body, top disk, and bottom disk of the container are made from four layers of containerboard laminated with moisture vapor barriers of undisclosed composition. The bag liner is fabricated by heat sealing from an inner layer of 2-mil conventional PE and an outer layer of 1-mil high-density ethylene copolymer film. The container is shipped collapsed, together with the sterile film insert bag and either a plastic dispensing tube for milk or a tightly fitting plastic cap for semi-solids (*e.g.*, ice cream). Assembly at the dairy is said to take just a few seconds: when the bottom disk of the container is pushed into position, the main body assumes its essentially spherical shape. This permits easy insertion of the plastic bag and the top disk. The container is then ready for filling. Used containers are collapsed and discarded.

The new system, which comprises 3-, 5-, and 6-gal. containers, eliminates the cost of metal cans and the associated expense of washing, sterilizing, maintenance, and deposit accounting.

There are also significant weight savings. An empty 5-gal. disposable container weighs 2 lb., compared to 16 lb. for the metal can.

Savings in storage space are also substantial. The new containers when empty require only about one-tenth the space of empty metal cans; filled they take up only one-half the space.

Finally, cost is low. The 6-gal. unit, complete, sells for 42¢, the 5-gal. unit for 40¢, and the 4-gal. unit for 35 cents. No exact cost figures are available from dairies, but spokesmen consider the price of the new "milk cans" to be somewhat lower than that of the metal variety.

The new containers are made and marketed by Weyerhaeuser Co., Camden, N. J. Specially formulated films by Celanese Corp. of America.

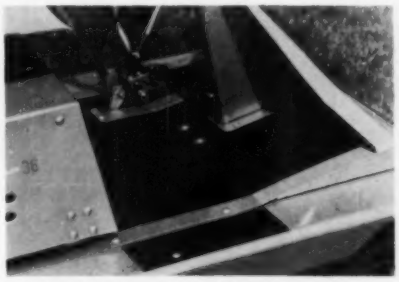
Vinyl mats at half the cost of rubber

By specifying pressure-sensitive-adhesive-back vinyl sheeting for the floor mats of its "riding mower," David Bradley Mfg. Works saved 45% in material and 50% in labor over previously used rubber flooring. The earlier material required manual bonding to the floor board, involving special tools, messy glue pots, and attendant clean-up time. All these are eliminated under the new system.

In addition to cost savings, the company, a Div. of Sears, Roebuck Co., also reports several performance advantages, among them:

1. No curl up at ends (as rubber mats tended to do);
2. Wearability;
3. High gloss and easy maintenance.

Vinyl used is a 12-mil sheet backed by a pressure-sensitive adhesive supplied by Avery Label Co., Monrovia, Calif. Weight is 1 lb./sq. ft.—rubber mats weigh two to three times as much. The success of the mats suggests uses in kick panels; foot treadle coverings; trunks; boat and station wagon flooring.



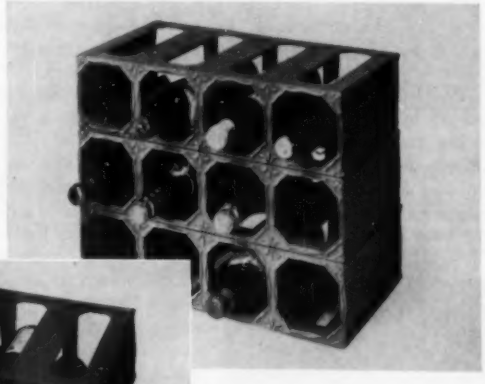
FLOOR MAT for this "riding mower" is made of vinyl, backed with pressure-sensitive adhesive. It replaces rubber, saves on material and labor costs.

Decorative wine rack of molded polystyrene

A modular wine rack, made up of injection-molded high-impact polystyrene components, not only serves as bottle storage space but can also double as decorative room divider.

Individual modules, which hold four bottles each, can be used singly or stacked to any desired height. Molded-in studs and depressions at top and bottom of the units mate to provide necessary stability. Molded French Provincial design appears on the front and back, providing the decorative touch necessary for use in living rooms, dining alcoves, restaurant dining rooms, etc.

Modules are molded in one piece on a 16-oz. injection press. Weight of shot is 20 ounces. Each module measures 17½ by 4⅔ by 9 inches. At the retail level, the racks are marketed as a unit comprised of three four-bottle components. The price per set is $10. They are developed and marketed by Hudson Valley Craftsmen Inc., Scarborough-on-Hudson, N. Y. Molder is Leaf Plastics Inc., Yonkers, N. Y.



(More Developments on page 154)

TWO COLLECTOR RINGS (outer one shown in detail) are molded of phenolic to form part of drive unit for silage unloader.

Automatic molding brings 36% cost saving

Production economies made possible by a changeover to a reinforced phenolic molding material have enabled the manufacturer of a collector ring for automatic silo unloaders to reduce the cost of the unit by 36 percent.

Former production methods involved manual casting of epoxy units. Parts are now produced on an automatic transfer press at a rate of eight parts per hour.

The collector ring functions as a key component of the lower transition assembly (circled in photo) of the silo unloader. It controls rotation of the drive wheel which picks up and feeds the silage. The unit is 8½ in. in diameter and is made up of two concentric molded rings. Molded-in metal rims and metal inserts provide the electrical contacts necessary for its operation.

The choice of a phenolic-bonded, chopped cellulosic, fabric-glass fiber molding compound for this application was based primarily upon the material's ability to impart requisite high strength and high dielectrical values.

According to the manufacturer, Magnetic Controls Co., St. Louis Park, Minn., the new production methods and new material have significantly improved the unit's appearance and performance characteristics. Previously, the moldings were painted; however, the integral color of the phenolic-bonded material produces a surface requiring no further treatment.

Northwest Plastics Inc., St. Paul, Minn., molds the collector rings on a 350-ton transfer press, using a single-cavity mold. The material, designated as F-M 1132-5362, is supplied by Fiberite Corp., Winona, Minn.

RP is wed to wood and aluminum in new ladder

Reinforced plastics, wood, and aluminum are the structural components of a new line of safety ladders. Salient features include high strength, low weight (a 20-ft. straight ladder, for example, weighs just 35 lb. and can easily be handled by one man), non-conductivity, and low maintenance which is said to make the ladder about 25% less costly than wooden ones.

Each ladder consists of: RP rail channels for flexural and impact strength; redwood channel cores for compressive strength; and aluminum alloy rungs for resistance to high torque and direct center loading.

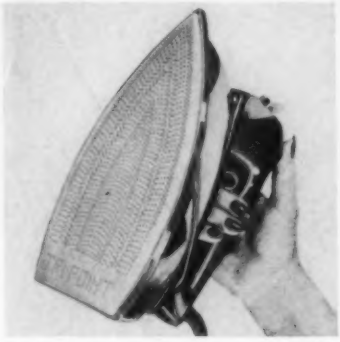
The RP rail channels are fabricated by hand layup of glass fiber mat, impregnation by liquid polyester resin, and matched-die molding of the wetted mat under heat and pressure in a 100-ton press. Two sizes of rail channel are produced; the smaller channel is fitted over the redwood core, then this section is covered by the larger channel. Rails of the longer ladders in the new line are additionally reinforced with resin-impregnated, longitudinal glass fibers along the wood core. The new line encompasses straight ladders, extension ladders, and stepladders in various lengths, and four-in-one models that can be converted into any of the above types.

The safety ladders are made by Hopfeld Industrial Mfg. Co., San Rafael, Calif. Polyester resins are supplied by Reichhold Chemicals Inc. and Chemical Process Co. Glass fiber reinforcement by Modiglass Fibers Inc., Div. of Reichhold Chemicals, and by Ferro Corp., Fiber Glass Div.

Fluorocarbon glider for easier ironing

A wafer-thin Teflon glider that can be fitted over the sole plate of any standard steam or dry iron, allows the housewife to iron any material, from cotton to the latest synthetics, with the same temperature setting and without fear of sticking or scorching. In addition, the attachment is said not to pick up foreign matter, such as lint or starch, not to stain clothing, and to prevent all scratching of the iron's sole plate.

The gliders are fabricated from compression-molded, cored billets, 18



in. long and 12 in. in diameter. Wafers of Teflon, 20 mils thick, are skived by knife from these billets, die-cut to shape, crimped at the edges, and fitted into aluminum frames. Patterned perforations are then die-cut into the wafer, and an attachment spring is added to the assembly.

The gliders are fabricated by Tri-Point Industries, Albertson, N. Y., from material supplied by Du Pont. The product, selling for $5.98, is nationally distributed by T-Fal Corp., Baltimore, Md.

New approach to one-can epoxies

By use of Chemical-Loaded Molecular Sieves, epoxy formulators can now convert many two-can systems to one-can recipes that have prolonged shelf life, low exotherm during cure, and good hardening rates.

Key to the system is a zeolite mineral crystal (in this case a synthetic metal, alumino silicate) which contains a precisely arrayed network of cavities interconnected by apertures of uniform size. Molecules that can pass through these apertures penetrate the crystal structure and are adsorbed by the cavity walls. Larger molecules cannot pass through and, thus, remain outside the crystal. The net result is that the crystal can act as an effective barrier between different materials.

There are two ways to liberate the

No area can be all things to *all* industries. But we've got down-to-earth facts that prove the Toledo-Northwestern Ohio area is right for Plastics Products Industries. These facts are reported in a study of the area by Fantus Research, Inc., one of the nation's foremost industrial location services. If you would like to evaluate this information in terms of your plant location plans, write R. E. Johnson, Manager, Industrial Development Department, The Toledo Edison Company, Toledo 1, O.

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adsorbed chemical. The first is based on zeolite's affinity for water. In the presence of water, a crystal loaded with a chemical will release that material and replace it with water molecules inside the crystal cavities. The second way is through the use of heat.

As applied to epoxy systems, the active hardener itself is adsorbed and held within the pore structure of Molecular Sieve adsorbents. It is thus isolated from the resin, since the larger epoxy resin molecules cannot enter the pores. At the proper time, the "caged" hardener can be released by the application of heat, the introduction of a displacing agent (moisture from the atmosphere is frequently sufficient), or both.

An epoxy coating formulation which has been stable for months cures at room temperature in about 8 hr. when cast in a 3-mil film and exposed to the atmosphere. An adhesive system cures in 30 min. at 220° F.

Three types of Sieves, supplied in the form of a dry powder, are offered:

1) Simple polyamine: will provide 1-year shelf life and cure at room temperature if displacing agent (water) is present during cure. Application: thin-coating or adhesive uses where atmospheric or substrate moisture is present.

2) Modified polyamine: for coating, bonding, or casting, if heats of 250 to 350° F. can be used. Special formulation is available if the polyamine is to be released by heat alone.

3) Tertiary amine: This catalyst can be released through heat, or displacement, or both.

No definite data are available on the effect of the addition of these "sieves" on the properties of the cured resin, except that it will act like a filler material. Preliminary tests indicate the following:

Clarity: Addition of CLMS results in opaqueness and no clear castings are possible. However, the resin can be pigmented in the usual manner.

Electrical properties: No effect on volume resistivity; some changes in dielectric constant. Significance of these effects will have to be established by user requirements.

Physical properties: Essentially the same as other filled epoxies.

The Sieves are produced by Linde Div. of Union Carbide Corp., New York. According to the company, one-can epoxy formulations based on them cost somewhat more than equivalent two-can systems (actual prices of CLMS so far produced range from $3 to $5/lb. in quantities up to 1000 pounds). However, the company feels that the convenience of the new system, the long shelf life, and the lower cure exotherm will offset the added cost.—**End**

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VYN-EZE for Polyvinyl
combination slip and anti-block additive for films, sheeting and tubing. VYN-EZE produces greater efficiency and speed in the winding, handling and converting of Vinyls – gives you a new standard for improved clarity along with anti-tacking characteristics. FDA APPROVED.

STAT-EZE for Nylons, Synthetic blends and Wool
overcomes static accumulation on carpeting. Also recommended for undergarments, upholstery goods and dresses made from synthetic fibers. Easy to apply by spray, sponge or immersion. Tenacious and hard to rub off.

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LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Viscoelastic Properties of Polymers," *by John D. Ferry.*

Published in 1961 by John Wiley & Sons Inc., 440 Park Ave. South, New York 16, N. Y. 482 pages. Price: $15.00

Written by an expert rheologist, this book is essentially a status report on the subject of viscoelasticity. A major purpose of the book is to assemble in one place information and techniques required by investigators and students working in the field. The book is equally good as a first text on the subject for novices. Also pointed out are needs for further work. Practical applications are given to demonstrate the usefulness of the rheological approach to problems. It is good background for those with a serious interest in the field of viscoelasticity.—*G. R. S.*

"Glasfaserverstärkte Kunststoffe" (Glass Reinforced Plastics), *Edited by H. Hagen.*

Published in 1961 by Springer-Verlag, Heidelberger Platz 2, West Berlin, Germany. 606 pages. Price: DM 69 (about $17.50). (In German).

Number 5 in a series of monographs, this volume is a newly revised, updated second edition of a work first published in 1956. Primarily a status report on the technology of fibrous glass reinforced plastics, the book is based largely on American practices and was originally written to inform the German plastics industry about such methods. Comprehensive in scope, the book presents well-detailed and documented chapters on all types of resins for reinforced structures as well as accessory raw materials, properties of glass fibers, physical properties of reinforced plastics, fabrication process techniques, finishing methods, test methods, uses in building construction and other applications, and a small section on patents. The book is an excellent "one-place" reference text for those engineers working in the reinforced plastics field and having a fluent knowledge of technical German.—*G. R. S.*

Acrylonitrile-butadiene-styrene. Properties, dimensional stability, color range, resistance to chemicals, applications, etc., for Cycolac ABS resins. 8 pages. *Marbon Chemical Div., Borg-Warner, Washington, W. Va.*

PVC plastisol resin. Features, applications, etc., for Marvinol VR-53, a special-purpose polyvinyl chloride plastisol resin for rotational molding, chemically blown film, hot dipping-cold dipping, and general plastisol compounding. 4 pages. *United States Rubber Co., Naugatuck Chemical Div., Naugatuck, Conn.*

High-frequency heat sealing. Published by a manufacturer of equipment for this process, "High Frequency Plastic Sheet Welding," by E. C. Stanley, is a hard-cover book which describes in simple terms the basic requirements and uses of high-frequency welding equipment, practical information on tooling, and examples of applications in a wide range of industries. 324 pages. Price: 35 shillings (About $4.20). *Radyne Ltd., Eastheath Ave., Wokingham, Berks., England.*

Plastics education. "Engineering Education in Plastics" discusses the need of specialized training to prepare an engineering student for a career in plastics, and recommends a curriculum to provide such training. 10 pages. *Society of Plastics Engineers, 65 Prospect St., Stamford, Conn.*

Chemicals for plastics. Bulletin lists description and application for a line of chemicals, organic intermediate chemicals, synthetic resins, and specialty chemicals for the plastics, chemical, textile, rubber, and allied industries, 8 pages. "Epoxy Resin Chemicals" is a separate brochure outlining the properties and applications for Pentamids, DDSA, Beta-S, and Terpox epoxy resins for coatings, adhesives, structurals, and electronic and electrical applications. 4 pages. *Heyden Chemical Div., Heyden Newport Chemical Corp., 342 Madison Ave., New York 17, N. Y.*

Chemicals directory. "Spencer . . . America's Growing Name in Chemicals" describes the company's facilities around the world, and lists the variety of plastics and chemicals that is produced. 20 pages. *Spencer Chemical Co., Dwight Bldg., Kansas City, Mo.*

Blow molded PE containers. "Blow Molded High-Density Polyethylene Containers—Collapse Problems and Recommended Solutions" discusses the effects of permeation, swelling, product instability to oxygen and light, solution of gases into product and hot filling, etc. Schematic drawings illustrate causes of dimpling, methods of distinguishing between causes, and eliminating and reducing causes of dimpling. 8 pages. "W. R. Grace & Co.—Now One Quarter Billion in Chemical Sales" reviews the history of the company and discusses its varied interests in the plastics and chemical industries. 20 pages. Former brochure available from: *W. R. Grace & Co., Polymer Chemicals Div., 225 Allwood Rd., Clifton, N. J.* Other bulletin can be obtained from: *W. R. Grace & Co., 3 Hanover Sq., New York 4, N. Y.*

ASTM Standards on Plastics. Compiled by Committee D-20 on Plastics, this 12th edition contains tests and specifications relating to cellular plastics, plastics pipe, epoxies, urethanes, plastisols and organisols, a test for measuring the tensile strength of plastics under impact conditions, and other recommended practices. Lists 204 standard specifications, methods of testing, and recommended practices, including 25 new standards. 1222 pages. Price: ASTM members, $8; non-members, $10. *American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.*

A Selected Listing of Testing Machines for All Industries. Catalog contains technical data on 461 testing machines, used in the plastics and other industries, including 69 categories of physical testing such as abrasion, hardness, moisture, impact, tensile and 64 additional categories. 20 pages. *Testing Machines Inc., 72 Jericho Turnpike, Mineola, N. Y.*

Coating techniques. Radiant heat reflective, low emissivity coatings, their properties and uses with high-temperature reinforced plastics are described in Bulletin 400-61. 4 pages. *Swedlow Inc., 6986 Bandini Blvd., Los Angeles 22, Calif.*

Plastics in Building is a comprehensive study of how plastics can be used for numerous building applications. Includes uses of polypropylene, acrylic sheet, PVC compounds, PVC sheeting, vinyl copolymer sheet, thermosetting resins, butadiene copolymers, vinyl polymers, PE building sheet, polyethylene, urea formaldehyde resins, and ICI's other lines of plastics. 104 pages. *Imperial Chemical Industries Ltd., Millbank, London SW1, England.*—**End**

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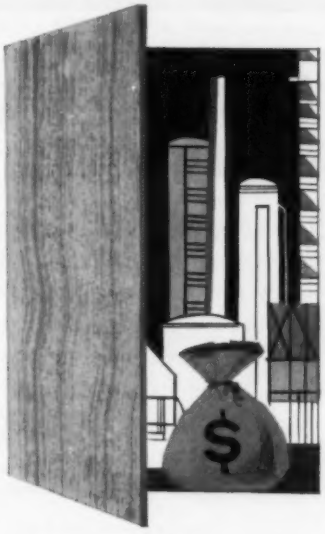

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7016

These containers were made from 'Fluon' I.C.I. p.t.f.e. by W. S. Shamban & Company, 11617 West Jefferson Boulevard, Culver City, California.

Containers made from 'Fluon' cut maintenance costs and simplify processing in the chemical industry

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The I.C.I. Plastics Division Technical Service is freely available to all customers through oversea companies, agents and representatives.

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Canadian Enquiries to: Canadian Industries Limited, Plastics Division, P. O. Box 10, Montreal, P. Q.

PF92/O/A

New machinery-equipment

(*From pp. 46-50*)

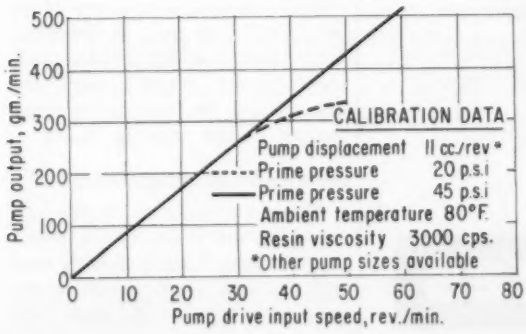
mium-plated mild steel; it is suitable for damp or dry service and, for economy, has no de-nippers. The guiders instantly detect web misalignment and automatically adjust for the deviation by tilting a pair of nip rolls, one set on each edge of the web. The sensor is a grooved and fluted wheel, which rides the web edge and which changes the tilt of the nip rolls in proportion to the web misalignment to keep the web running true. Operation is entirely mechanical, using spring actions. Guides operate at any angle, in any position, on any width of any flexible material. *Mount Hope Machinery Co., Taunton, Mass.*

Spray painter

This machine is designed for automatic, controlled spray painting of irregular or "fade-out" patterns, such as the blush on plastic doll faces, or other jobs ordinarily done by hand with an air brush. The small, portable (base dimensions are 24 by 24 in.) bench unit, known as the Snap Tap painting machine, does not ordinarily use masks but can be adjusted for their use. Two spray guns are mounted on universal joints for adjustment to any angle and are actuated by a "snap-tap" of the control button. Paint quantity and length of spraying cycle are adjustable. Demountable work holders are designed to handle a large variety of small parts. *Conforming Matrix Corp., 787 New York Ave., Toledo 11, Ohio.*

Polyurethane foam mixer-dispenser

The Foamix Type 61 machine blends urethane resin ingredients in exact proportions to produce foams of specified density, and delivers the foaming mixture in metered shots or as a continuous stream. Capable of automatic, semi-automatic, or manual operation, the unit has a detachable mixing-dispensing head (for spot pours) which is normally mounted on an adjustable boom which can be set anywhere from 40 to 52 in. above the floor, and which may be swung horizontally on an arc of 270°. Mechanically synchronized metering gear pumps are driven at infinitely variable speed. Component ratios are changed by changing gears. One gear set, or ratio, is supplied with the basic unit; other gear sets for ratios up to 99:1 are extra. Average over-all metering accuracy is 1% up to 15 lb./min. mixing rates. Output is controlled by controlling r.p.m. of the metering pumps. (See graph below). Calibration is supplied with each unit. Blending head is protected from clogging by component shut-off and recycle when head is not dispensing; automatic solvent purge cleans system on shut-down. Unit is supplied without feed tanks, heating or cooling systems, or spray heads—all of which are available as optional extras. Manufacturer also supplies complete system design service, repair parts, and foam raw materials. *PolyStructures Inc., 41 Montvale Ave., Stoneham, Mass.*—**End**



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WITH
INDEPENDENT
RAM ACTION

For highest quality finished pieces, Rotojet features screw pre-plasticizer with independent ram action. This means lower operating temperatures, minimum shrinkage, and reduced orientation.

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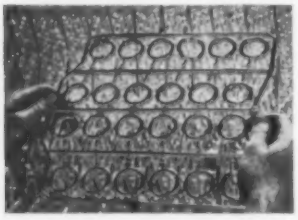

Premier, like so many other leading finishers, has found that an investment in a Stokes metallizer is worth repeating because it pays off in quality products at high production rates and low operating costs.

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STOKES

Glamour plastic

(*From pp. 78-82*)

If this comes about, automotive glazing faces some drastic changes, particularly in models where designs call for compound curvatures.

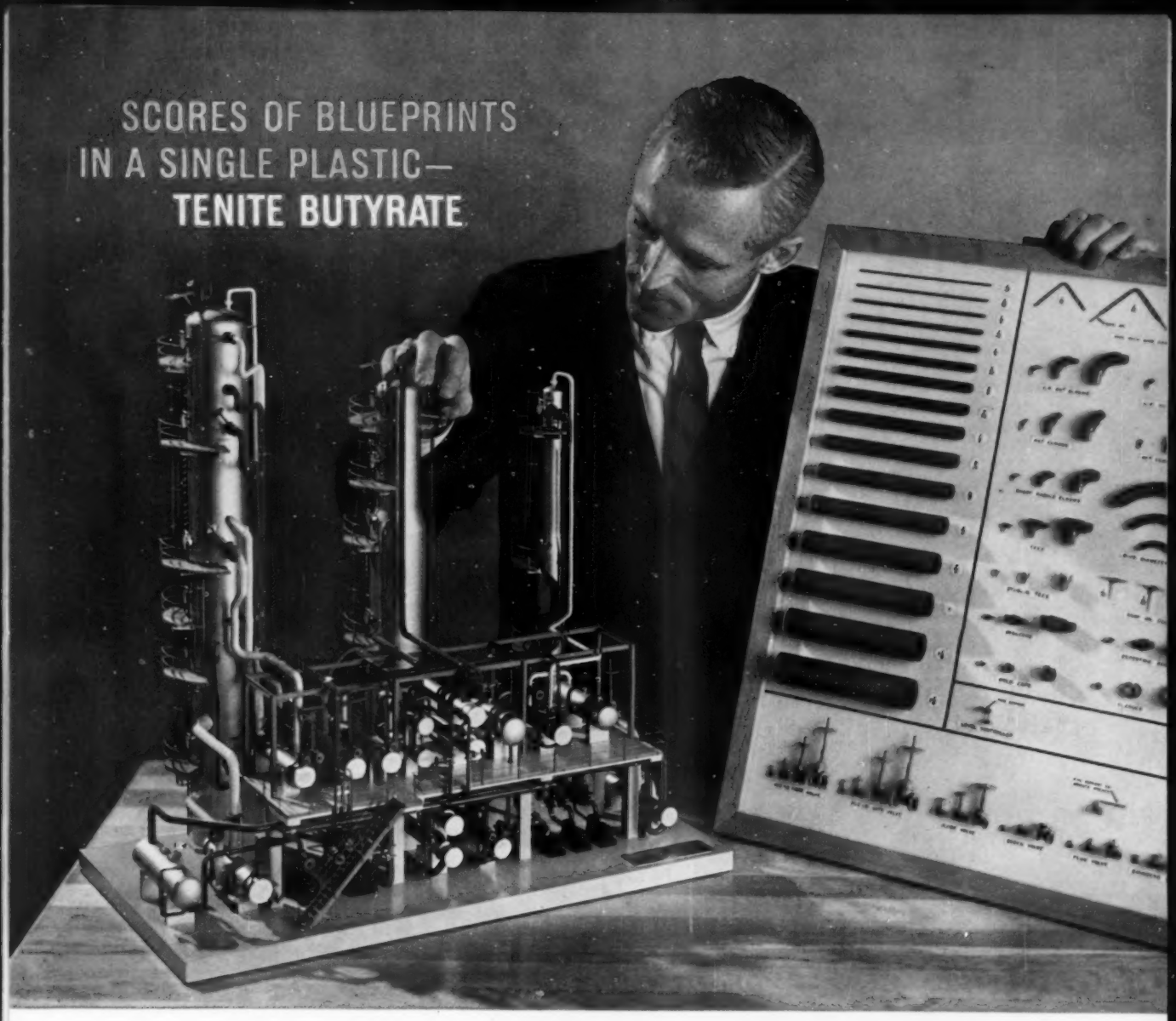
Quite a few companies are in the cast and extruded sheet business. Rohm & Haas Co. is admittedly the biggest factor in cast sheet. Cadillac Plastic and Chemical Co. extrudes sheet and also casts rod and tube. Cast Optics Corp., Hackensack, N. J., has an automated casting plant, as announced last month. This company has three other plants and consumes monomer at the rate of 7 million lb. per year, making all standard and custom colors. Polycast Corp., Stamford, Conn. (see *Modern Plastics Encyclopedia Issue*, 1962, p. 758), and Borne-Lite Corp., Landover, Md., like Cast Optics, both cast sheets to Du Pont standards and are allowed to use the Monocite trademark. Southern Plastics Co., Columbia, S. C., and Amplex Manufacturing Co., Philadelphia, are sheet extruders, serving the sign and architectural fields.

In the interest of economy there has been a considerable effort expended on biaxially oriented thin MMA sheet—down to 20 mils or less. The Plax Corp., Hartford, Conn., has such materials and is promoting them for use in greenhouse glazing, formed packaging, and displays. Rohm & Haas Co. recently announced Tuffak, an oriented acrylic sheet claimed to have exceptional optical properties and weather resistance. This material is reported to have better solvent craze resistance than unoriented MMA, and can actually be punched into small electronic parts, for example.

Goodyear Aircraft Co.; General Plastics, Tacoma, Wash.; and Douglas Aircraft Co., Santa Monica, Calif.; as well as Swedlow Corp., have biaxially oriented thick sheets for the aircraft industry, and it is reported that they are working toward thinner oriented sheets.

New resin developments

There are three major developments in new resins in the methacrylate field. One is Baker's new high-heat-resistant type with unique properties. It is re- **(To page 163)**



Built from stock components made of tough Tenite Butyrate, a model like this short-cuts the designing of a chemical processing plant or oil refinery. In effect, it provides a three-dimensional set of plans.

The number of required drawings is reduced, and photographs of the model can be of real use in actual construction, for the Butyrate pieces are molded or extruded to scale with extreme accuracy. Since Butyrate plastic is strong and tough, the parts can be joined by push-fit, and complex models are quickly put together. The plastic colors aid in coding the process flow. And the light weight and strength of Tenite Butyrate permit the model to be shipped abroad economically, where it overcomes many problems formerly caused by differences in language and drafting technique, and saves valuable time in personnel training.

The advantages of Butyrate—toughness, formability, colors (more than 42,000 formulated by the Tenite Color Laboratory), gloss, light weight, and economy—are the basis for scores of successful products. End-uses range from molded fishing lures to huge outdoor signs of thermoformed sheet.

In fact, Tenite Butyrate is formulated with so many useful combinations of properties that your own planning may benefit from knowing more about this versatile plastic. Qualified technical representatives will help. For information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Model component parts
of Tenite Butyrate
made and marketed by
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V 308	332 grs.
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portedly harder than standard MMA, thus has better scratch resistance. Its index of refraction is such that lenses molded from it may be thinner in cross-section than those of standard material. It stands up well to perfumes and essential oils, so could be a natural for cosmetic closures. It is declared to be a copolymer. In injection molding it is claimed that cycles may be cut by 20% because it solidifies at higher temperatures than MMA. To date the material is being used in critical instruments where thermal shock resistance, impact, and high clarity are involved, in edge-lighted aircraft instruments, in escutcheons for electric ranges. The price of Bavick-11 resin has recently been reduced to $1/lb.; an ultimate price of 75¢ is projected.

Another fairly new material, also a copolymer of MMA, is Implex which appears in five formulations, the latest of which is Implex R. This Rohm & Haas material has within the last month been reduced to 39½¢/lb. and is targeted toward markets now dominated by other impact materials such as the ABS polymers and the acetals. Implex R is twice as tough as the next nearest formulation, which has the designation F. It was a natural for ladies' shoe heels and has taken most of that market. It can contain oils and other difficult liquids. It is already being used to replace metal and reinforced polyester in outboard motor shrouds. It is being used in housing for soft drink dispensers. Finally, the material can be blow molded. A current example of this is a hairdrier housing.

Latest MMA copolymer is Zerlon methacrylate-styrene from Dow Chemical Co. It is available in extrusion and injection-molding compounds, is already accepted in unbreakable cocktail glasses and tumblers, in automobile parts and, like the other new crystal acrylics, is targeted toward the heat-resistant areas of application.

More elements in the methacrylate field, more interest in these materials on the part of designers and engineers in end-user fields is bound to generate more research and the development of ever-better materials. So the glamour plastic develops more muscles. Like Marilyn Monroe, MMA looks mighty good in overalls.—**End**

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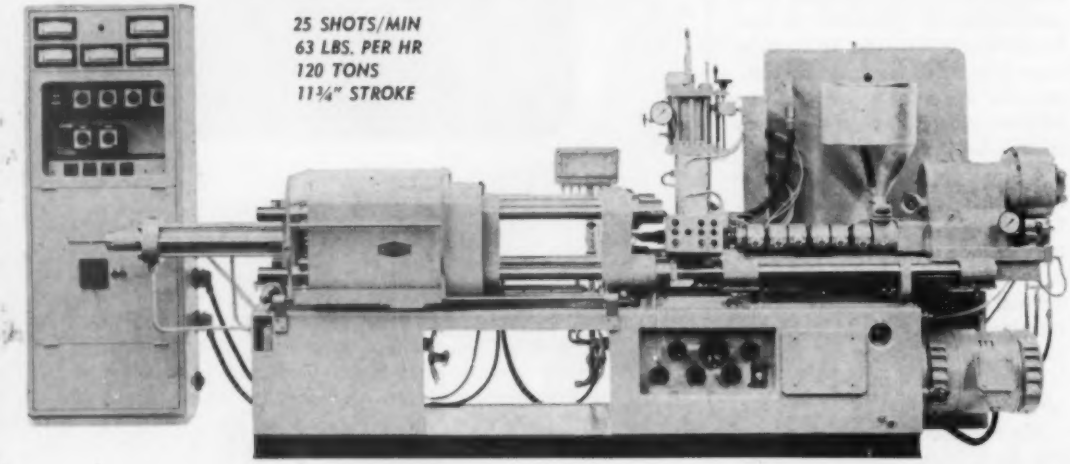

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Ice-cube container

(*From page 86*)

during which the powder is fused and the beads are expanded. This is not foam molding in the conventional sense. No PS foam-molding equipment is used, and there are no steam probes. The process is more akin to the rotational molding of powdered PE[1], involving use of an oven baffled for various temperature zones, arrangements for the molds to rotate in several planes, and a cooling station. For the ice bucket shown, 12 molds are used; and present equipment can handle maximum dimensions of 12 by 12 by 8 inches. Modifications to accommodate larger sizes are underway. All production equipment is of the molder's own design.

Costs for this process are hard to determine. They will vary with the thickness of the PE skin (which can range from 0.005 to 0.015 in. with ridges of 1/16 to 1/8 in.), the density of the foam (which may extend from 1 to 5 lb./cu. ft.), and with the shape of the product. The retail cost of the ice chest shown is about $5. The chest is part of a kit that also contains two standard ice-cube trays and a cover. It is sold through RCA Whirlpool and Sears, Roebuck, and to other outlets as optional refrigerator equipment.

Among the markets this development is expected to open are:

Picnic coolers: Molded PS foam has been rather limited here, both in terms of hardness and appearance. The new skins overcome both of these objections.

Lunch pails: New construction offers insulation combined with ruggedness.

Packaging: The cushioning properties of the foam can now be combined with the toughness of the PE skin. The packaging applications seem particularly interesting since the PE skin can be applied selectively to parts of the foam.

Laboratory uses: Sanitary insulated containers for biopsy specimens, providing ease of handling in transit and storage.

Marine uses: (*e.g.,* buoys, floats, tackle boxes, etc.) complete the list of potential markets.

Credit: Container molded of material tradenamed AIRCO by Cortland Line Co. Inc., Cortland, N. Y.—**End**

[1]For details of this process, see "Broader markets for powdered PE," MPI, Nov. 1961, p. 90.

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25-Ton Dake laboratory press used to mold experimental resins in a Grand Rapids, Michigan, varnish company.

DAKE CORPORATION
648 Robbins Road, Grand Haven, Mich.

Throw-away parts

(*From pp. 84-85*)

efficiency by 35 percent. Convoluted stainless steel disks are available, but are very hard to clean.

Several advantages were obtained relative to the previously used glass parts. First, of course, is unbreakability, which solved one major maintenance problem. Second is the problem of coagulation defects. To avoid this, glass components had to be coated with silicone grease that had to be removed following each use and then reapplied for the next operation. With polycarbonates, this treatment has become unnecessary.

Additional factors dictating the choice of the material were: 1) its dimensional stability, which assured form retention and thus avoided destructive blood turbulence; 2) good surface finish which prevents cellular damage to flowing blood; and 3) transparency, which allows quick visual observation.

All components are injection molded in single-cavity molds. The bubble trap, the suction return filter, and the disks are sprue-gated, the fittings are side-gated. Cylinder temperatures and cycles are as follows: suction return filter—550° F., 80 sec.; bubble trap—500° F., 47 sec.; fittings—625° F., 20 sec.: and disks—625° F., 45 seconds.

No post-molding operations are needed with the polycarbonate components, except for the boring of holes into the bubble trap and suction return filter (a total of seven) to accommodate the fittings. Boring these holes was found to be more economical than building molds with side cores.

With the success of this application firmly established, work is now in progress to manufacture oxygenator shells of polycarbonate as well. The economics here are as impressive as for the smaller parts. For example, a 15-in. stainless steel-glass oxygenator costs $825; injection molded it will come to about $45. In a 21-in. unit, respective costs are $925 and $75.

Credits: Oxygenator unit developed by University of Maryland School of Medicine, Baltimore, Md.; parts molded by Fawn Plastics Co. Inc., Timonium, Md.; Lexan polycarbonate resin supplied by Chemical and Metallurgical Div., General Electric Co., Pittsfield, Mass.—**End**

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Nylon parts

(From pp. 92-93)

the same advantages to the much larger components.

Abrasive handling equipment. Pieces inserted in foundry core boxes have reportedly shown 10 times the wear resistance of hardened steel inserts formerly used. It is anticipated that entire core boxes and draw plates can be advantageously fabricated of monomer-cast nylon. Components of block-making machines have also been successfully produced.

Gears. Again, nylon has already proved its advantages in small molded applications. Now, large gears can be economically produced; those in service already are significantly outperforming gears made of other materials.

Roll covers. In one application involving back-up rolls against which lace paper doilies are die-cut with sharp blades, monomer-cast nylon proved superior to any other material tested. It has also been successfully used in rolls used in printing wallpaper. Paper drive rolls made with monomer-cast nylon covering have reportedly outlasted rubber-covered rolls by a factor of 10, and they cost only one-fourth as much. Tests indicate that further economies may be realized by casting MC nylon directly around a metal roll, thereby eliminating boring and fitting of separate machined covers.

Slipper blocks. These are used in drive shafts of steel rolling mills. Nylon has proved to be substantially more effective than brass, primarily because of better abrasion resistance and resistance to peening under shock loads. Other potentials in the steel industry include guide blocks, forming fixtures, and wear plates.

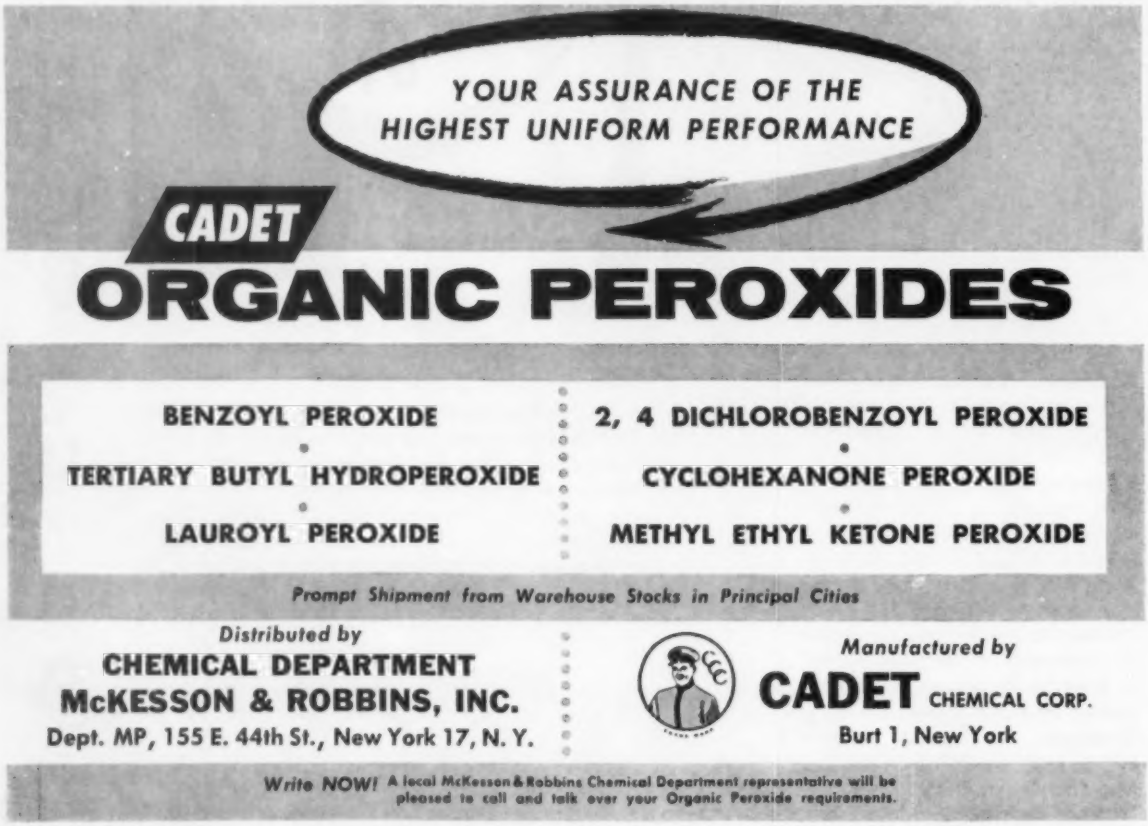
Miscellaneous. Drilling chucks for self-propelled rock drills, large hydraulic back-up rings, guides and bushing on railroad braking equipment, cams on automatic screw machines. In addition, there are several potential applications that hold promise but have not yet been evaluated. Among these are suction box covers, metal-drawing and roll-forming tools, journal stops, and nuclear shielding (where temperatures preclude the use of polyethylene resins).

In general, operations in monomer casting of nylon and in metal casting are similar. Both processes require a blueprint of the part, fabrication of a pattern, a mold, pouring into a mold, and solidification of the part. But there are differences, such as:

1. Molds for monomer-cast nylon must be non-porous because of the low viscosity of the melt. Sand molds used in metal casting cannot be employed. Most metals are usable, and ceramic and glass materials have also been used.

2. Monomer must be poured at exact temperatures and catalysts must be carefully added. Since nylon monomer sets up in the mold by chemical polymerization, while metals set up by heat loss, the chemistry of the polymerization process and temperatures employed become critical.

Credits: MC nylon casting technology by The Polymer Corp., Reading, Pa., under license from Monsanto Chemical Co.—**End**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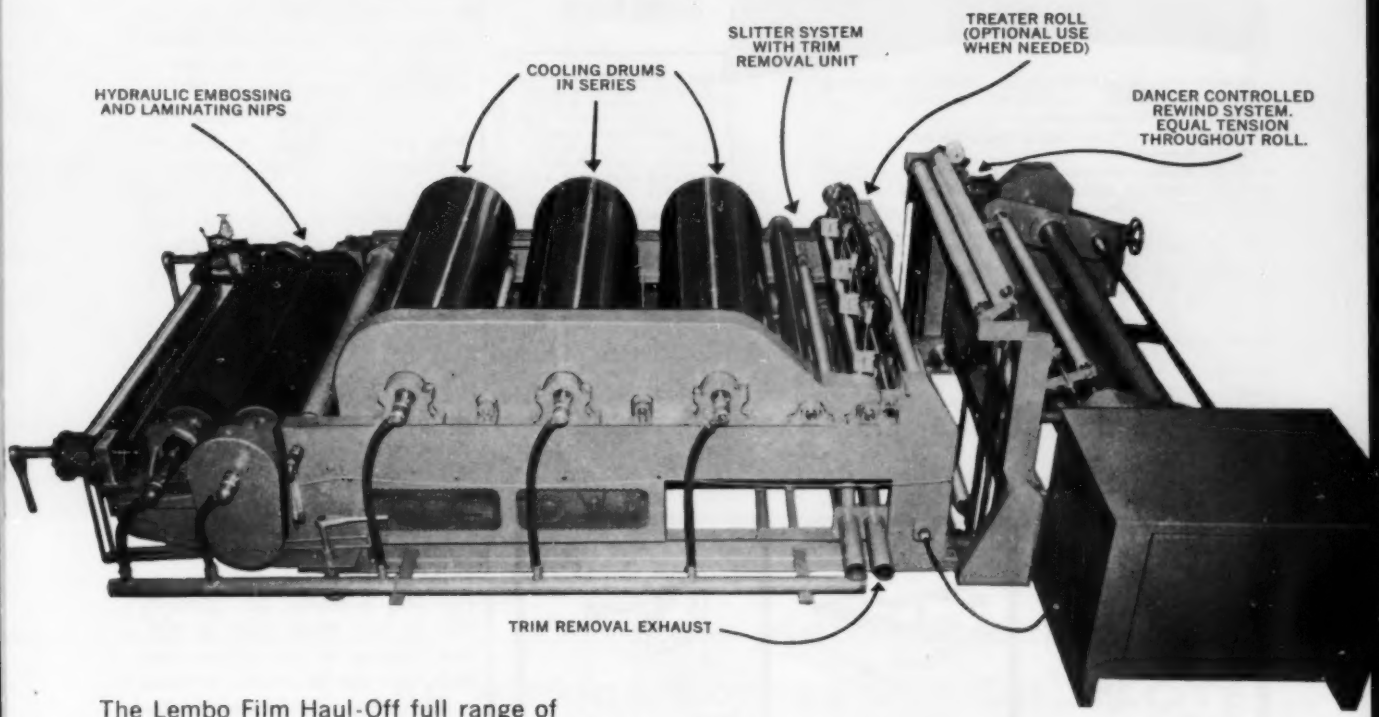
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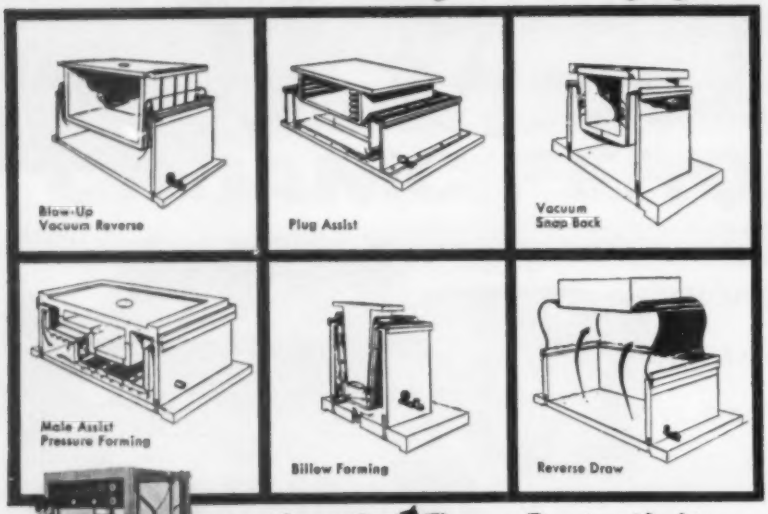

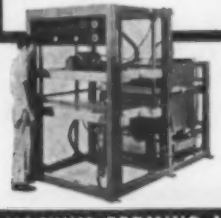

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VACUUM FORMING MACHINES FOR ALL NEEDS — BLISTERS TO BOATS

Polypropylene

(From pp. 87-91)

from roll to roll—all these differences are ironed out when the ends are sealed together and the film is heat-shrunk.

Oriented films' greatest use now is for phonograph record albums and bundling (several units in one package), but there seems little reason why it can't be used for poultry, processed meats, bread wrap, textiles, hardware (see photo, p. 89), and toys, whether it is shrunk or not. It is also suggested for use in laminates similar to those which now incorporate cellulose acetate. Book covers and calendars are examples. Ability to withstand flexing is a helpful property in these applications. Oriented PP film is also invading some Mylar markets, particularly for electrical insulation, but it is not expected to take over for Mylar in all areas. But it *is* boilable and could be used for pouches for boil-in-bag foods. As a laminate with foil, it may prove well worthwhile.

Latest entry into the ranks of producers of oriented PP film is the Cryovac Div. of W. R. Grace & Co. Just as this article was being prepared, the company announced commercial availability of a biaxially-oriented film with a balanced orientation: equal stretch—and subsequent heat shrink—in both directions. The company claims it is the most effective moisture-barrier film available, has strength five or six times that of PE, and, because of its stiffness and high slip, can be readily handled on high-speed overwrapping equipment. It is also now in use on trim-seal machines, where sealing is accomplished through either electrical impulse or hot wire cut-off. Cryovac is supplying a full line of this equipment including trim-sealers, shrink tunnels, and conveyors, as part of its Series Y film program. It could be that the company will soon be competing with itself, since it already sells vinylidene chloride and irradiated PE shrinkable films for smoked meats, poultry, and cheese. The price for Cryovac PP film is 2 to 2.8¢/M sq. in., depending upon gage, coatings, and type of winding. This adds more confusion to the price structure, since this is the first indication that

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oriented film may yet be available at almost the same cost as unoriented film.

Printing on PP film

Until a few months ago, and even today to some extent, there have been complaints that printing on PP was extremely difficult. This problem was supposedly the fact that inks would not adhere to the film. But apparently some printers have learned how to control this problem; furthermore, film is now generally more uniform, which aids in controlling press roller pressures. One converter is reported to have printed 15,000 lb. of film to be used for overwrapping valentines for the 1962 season. In this case, the end-user is taking advantage of PP film's ability, when properly stabilized, to withstand long storage without becoming brittle.

The wrinkling that some printers also complained of is caused by uneven gages or uneven tension and here again the printers have had to learn that PP must be handled differently than PE.

A higher web-drying temperature can be used with PP, since it will resist more heat than PE, and, because of this higher temperature, PP can be run faster on a printing press than other plastics. Because of its greater stiffness it can be run with very little distortion.

When printed film is to be sealed, there should be an unprinted portion where the seal is to be applied, since the ink is not sealable. Also, the ink in near proximity to the seal should be heat resistant.

The criticism that PP film for printing involves vast spoilage because such wide strips must be cut from each edge has been denied by at least one producer. The claim has been made that gage uniformity on the edges is so variable that it can't be used. The producer explains that, even though the chilled roll is 72 in. wide, no one ever attempts to make PP film wider than 60 in., and edges are further trimmed 3 in. on each side. The 54-in. width remaining is then slit to narrower measure to meet the customer's desires.

Film is treated either electrically or by flame before printing, just as is PE. It is believed that film requiring no surface treatment may soon be available for printing. The inks used for PP are similar to those for treated polyethylene, with slight modifications made by the ink manufacturer.

Bag making possibilities

There are many who believe that cast PP film is not adaptable to bag making—at least not on a big scale. The film welds together on the cut-off, and on a side-weld seal the hot knife leaves hair-like strings. It also may fail under sharp impact, like dropping a 5-lb. bag of potatoes. Small bags for such things as hosiery may become practical but not bags for sharp objects that are subject to sharp impact. However, the better low-temperature properties and impact resistance of biaxially oriented PP film should make possible a number of bag packaging applications.

Neither is tobacco presently considered a suitable material for packaging in PP. PP's flavor retention may be better than PE, but there are no good tests as yet. Still, some producers feel oriented film may eventually make a considerable showing in this market.

Methods of production

Blown, lay-flat film, the first large-scale and most commonly used method for making PE, is impractical in PP because it leaves a haze and poor impact resistance (but the pace of film development is speeding up—this sentence may be out of date a year from now).

The most common way to produce PP film today is by use of a chilled roll. This is what the industry calls cast film, even though it is very poor nomenclature. True cast film in the plastics industry generally refers to use of a solvent system, with a doctor blade operation from a fountain. However, the so-called cast PP or PE film is extruded onto a chilled roll or into a water bath. Perhaps it should be called a slot-die extruded, chilled, or quenched film. Extrusion into a water bath might allow use of some slip agents that can't be used with a metal roll. Some additives extrude or plate on a chilled roll and the plating is later picked up by the film. But in the water bath process, the wet film often carries too much water over into the wind-up and creates some problems. Nevertheless, some producers have worked

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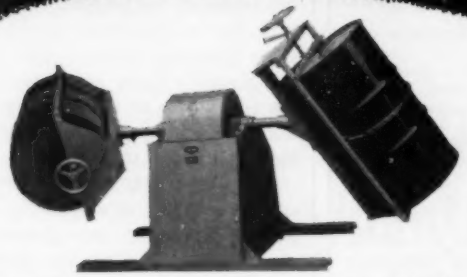

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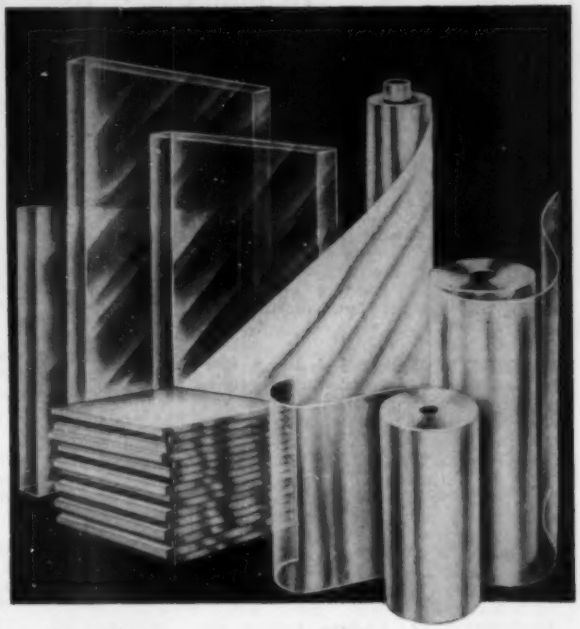

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Plexiglas & Acetate with Embedments		X	X		
PVC		X	X	X	X
Polypropylene		X	X		
Polyethylene—Regular	X	X	X	X	X
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very successfully with the water bath technique.

The hot plastic emerging from a slot die has to be quenched sharply to develop the greatest clarity and toughness. When the hot film first comes from the die, it is water clear; but, when it begins to cool, an almost imperceptible haze appears across the width of the film. Control of the distance between the die lips and that haze or "frost" line is the important factor. Fast cooling of the film produces smaller crystallites and results in better optical and strength properties.

Most producers are now using, or are experimenting with, an air-knife used in conjunction with the normal chill-roll equipment. This is said to give exceptional clarity and gloss as well as a substantial increase in impact strength. The resultant film is claimed to be just as clear as cellophane.

The air-knife is applied just prior to the chilled-roll contact and helps to chill the molten film quickly. The air stream from the knife also presses the extruded film into more intimate contact with the surface of the chill roll. The faster chilling provides better clarity.

Surging, a problem mentioned earlier, is partially controlled by the above method. PP comes through the lips of the die and spreads out almost like soup. A restriction in the center of the lip forces a more even flow so the edges will be the same thickness as the middle and the air-knife helps straighten out the edges. Use of the air-knife results in significant improvement in film clarity and strength.

The above example is given to emphasize that techniques in improved processing are happening almost every day. This is a characteristic of the plastics or chemical industry. One respected old-timer in the industry succinctly expressed the idea when he stated: "Give us the proper resin and we will find a way to process it."

Perhaps the one exception to this all-problems-are-solvable rule is price, because a naturally high-priced raw material can't compete for the same job with a lower-cost resin. An example is methacrylate *vs.* polystyrene. But as mentioned many times in this series of articles, PP is a potentially low-cost resin that some day will be

right in there with a cost factor that will help it to compete pricewise with almost any film.

Uses other than packaging for PP film have not yet been vigorously promoted by the industry. Its use as a 5-mil cable wrap has already been mentioned.

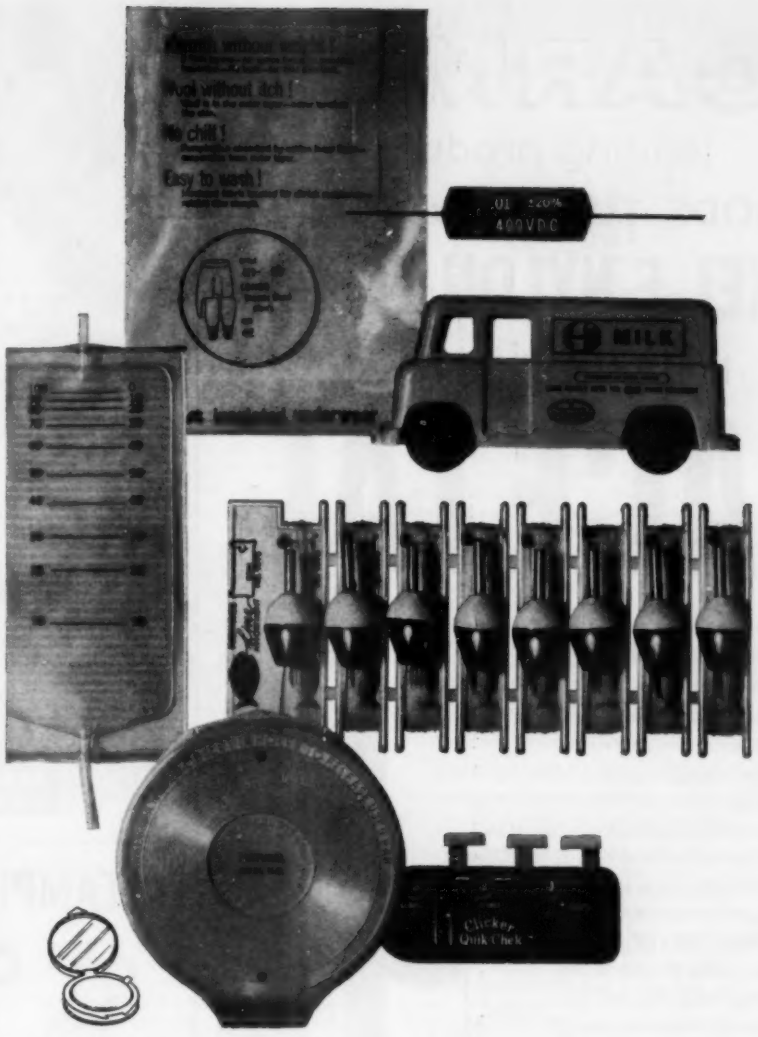
Such use is said to represent about 4 million lb. of Mylar a year. If PP captures this market, fewer pounds will be used because of its lower density.

As a laminating film, PP—joined to itself or to other materials—may eventually have several uses (most of those listed in the box on p. 91 are for packaging). It's too early to tell whether or not it will ever be used for such things as glazing, tarpaulins, and building.

It has already a few uses as an extruded sheet material in thicknesses of from 3 to 10 mils. As a sheet material today, the principal use is for lining electroplating tanks. Laminated thicknesses of from ⅛ to 2 in. are used. Seiberling, as an example, is supplying PP sheet in single thicknesses of from 0.010 to ¼ inch. In the electroplating tanks, PP laminate is subject to hot chemical baths at 220° F. and drying oven temperatures up to 300° F.

Use of PP sheet in vacuum forming is still limited because of the same problem existing with PE—the heating and cooling cycle is too long. But even in this difficult technique, progress is being made. And a few industrial tote boxes that are subjected to temperatures of 212° F. or more while carrying hot items are in use.

Anyone who has read thus far must realize that the future of PP film is loaded with "ifs," "ands," and "buts." Nevertheless, these problems are not unusual in plastics; and, because of PP's splendid inherent properties, plus its potential comparatively low cost, the technicians will work more industriously than ever to improve handling techniques and develop markets. It is as impossible to believe that PP film development will become stagnant as it is to believe that Americans will stop drinking coffee. No one at this time is expecting PP film to achieve the same volume as PE film, but the probabilities are good that poundage will reach into the hundred millions before this decade is over.—**End**



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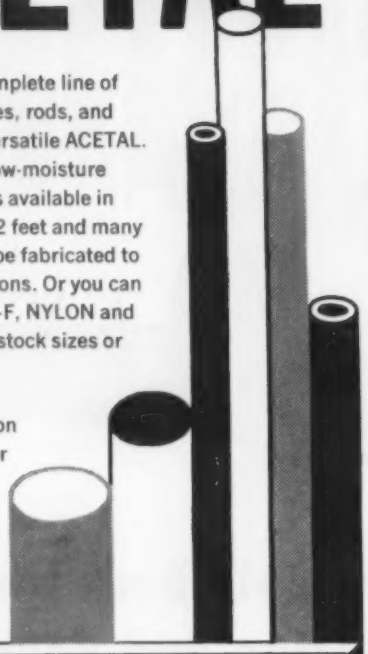

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Decorative effects

(*From pp. 94-95*)

For plastic film and sheeting, many attractive effects are obtained by embossing the surface. In the case of transparent plastics this technique has opened up an interesting series of possibilities. By embossing the surface away from the viewer, total internal reflection of light at the embossed surface is achieved. This produces extremely bright reflected highlights (Fig. 1, p. 94). By appropriate design of narrow reflecting surfaces, a brushed-silk or metallic-thread effect results. Other embossing patterns produce the effect of silvery or pearly rings.

Specularly reflecting pigments

There are several distinct classes of pigments which are characterized by plate-shaped pigment particles and the presence of a reflecting surface thereon. As a result, the amount and color of light seen by an observer is highly dependent on the angle of incident light and on the line of sight relative to the surface of the pigment particle. The appearance is one of a series of highlights rather than of a uniformly colored surface. These pigments are discussed below.

Metallics

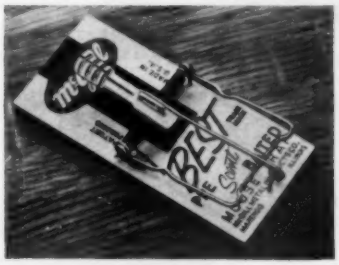
A class of pigments consisting of thin **aluminum** flakes produces a wide range of silver effects. These pigments are manufactured by ball milling either a disintegrated aluminum foil or a rough metal powder, and then polishing to obtain flat, brilliant surfaces on each particle. The finest sizes of these pigments, which pass through 400-mesh screen, show the highest hiding power but are quite gray in hue and generally produce a soft brushed lustre rather than a metallic brilliance. Increasing the particle size (*e.g.*, using 150- to 325-mesh particles) results in considerable increase in brilliance at a sacrifice of coverage or opacity. Still further increase in particle size (to approximately 80-mesh or larger) produces a progressive improvement in brilliance, but results in the individual pigment becoming visible. These large particle sizes also require special application techniques because they clog spray

TENITE DEVELOPMENT LABORATORY
DOINGS AND FINDINGS

A BETTER MOUSE TRAP

Correspondents on the man-versus-mouse front tell us of a new trap calculated to lure man's ancient foe straight to doom. No bait required. The attraction is the trap's special trigger, treated with a scent that apparently wafts forth powerful mouse-appeal.

The trap manufacturer uses tough Tenite Butyrate plastic for the trigger and adds the scent—his own highly researched, secret formula—during molding. For the sake of skeptics, human or rodent, the molded trigger design includes a holder for bits of cheese or bacon. But so irresistible is the prescented trigger itself, we are told, that shipping cartons for the traps have actually had to be treated with a mouse-repellent. Such are the wonders of modern chemistry.



And speaking of wonders . . . packaging the traps in new bags made from film of Tenite Polyethylene appears to remove a psychological barrier for women shoppers. Normally reluctant to touch even a new mouse trap, the ladies reportedly pick up the packaged traps with scarce a qualm.

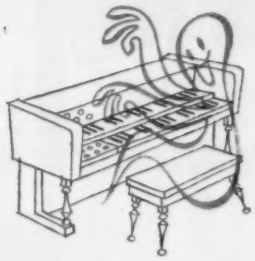
Tenite Butyrate and Tenite Polyethylene are highly adaptable to unusual, as well as conventional, product needs. For technical details and advice on processing these versatile materials, contact your nearest Tenite sales representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *Plastics Division,* KINGSPORT, TENNESSEE.

MORE ON THE COPPER DISH TEST . . .

Last DOINGS AND FINDINGS, we told you how pure Tenite Polypropylene is — 99.99% before special additives — and we explained that this purity resulted in a high resistance to oxidation. We even described the copper dish test which produced the results on which we based our claim to great resistance against oxidation for Tenite Polypropylene. This test, we neglected to add, was contributed to the plastics industry by Bell Telephone Laboratories. It is only one of the many ways in which Bell has helped the industry select suitable antioxidants for polyolefins. The copper dish test is, in our opinion, a great test. Try it . . . with Tenite Polypropylene.

THE QUIET WORLD OF RESEARCH

An electric organ has been playing day and night for over two years, but



not a single note has been heard. A television set turns itself on each morning at 8:00 A.M., plays for 12 hours, and then turns itself off.

These ghostly goings on in the research laboratories at Kingsport have been arranged to test the electrical stability of film made from Eastman's new Tenite Polyester.

The organ contains fifty uncased capacitors wound with this film. They range from 0.001 to 0.025 microfarads and are part of a resonant circuit that produces pitch by creating and subdividing a basic frequency of 2,500 cycles per second. Over an 8-month interval of continuous operation, the basic frequency varied by no more than eight cycles per second—indicating unusually high electrical stability.

(Since the circuit is tested electronically, there is no need for an amplifier. Consequently, the organ remains mute.)

Our robot television set contains 20 uncased capacitors wound with film of Tenite Polyester. Over the past two years, tubes have blown and potentiometers have burned out, but not a single capacitor has failed.

Supplementing the "in use" data, accelerated aging tests have also been run. Results indicate that 4 out of 5 uncased capacitors made from film of Tenite Polyester will function at 140°C. and 400 volts per mil for as long as five years.

The great durability of Tenite Polyester plastic is due primarily to its resistance to humidity. Even after 21 days of testing at 100% relative humidity and 110°C., the uncased capacitors remain intact and can be handled without special care.

Note the word **uncased.** The properties demonstrated by these tests mean substantial savings in making capacitors . . . they eliminate the need for casing. In a conventional capacitor, the case represents a major part of cost.

Film from Tenite Polyester is manufactured and marketed by Terafilm Corporation under the trademark "Terafilm." For more information about its properties and uses, write to Terafilm Corporation, Canal and Ludlow Streets, Stamford, Conn.

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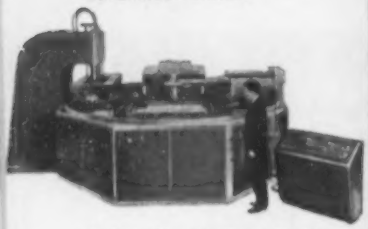

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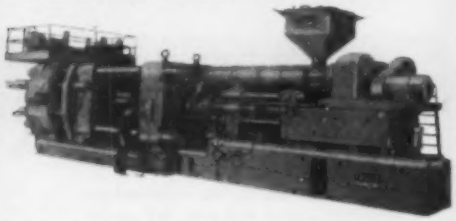

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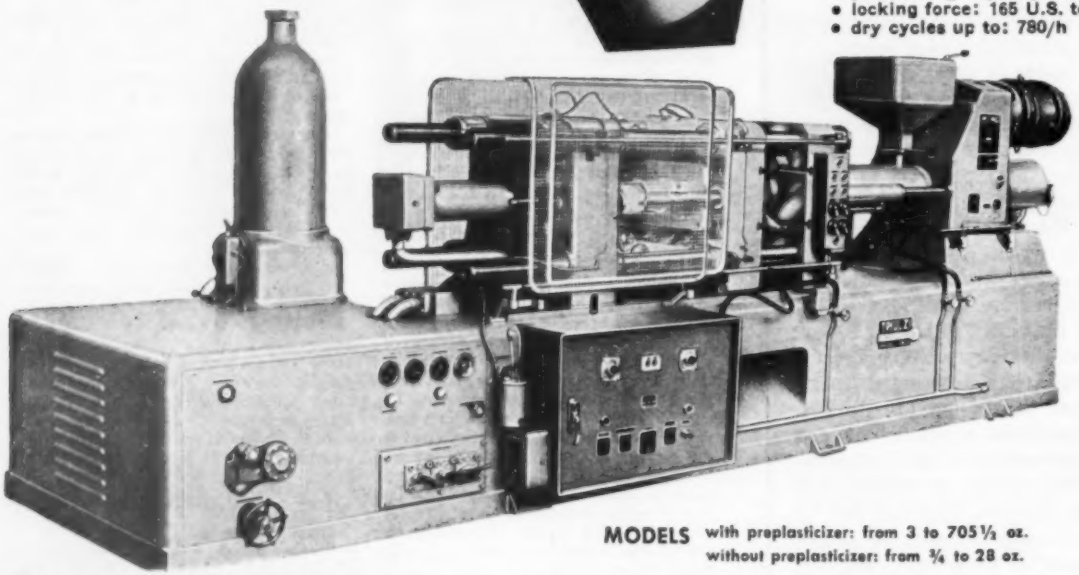

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nozzles, engravings, silk screens, extruder screens, etc. Aluminum pigments readily lend themselves to blending with various color pigments, producing a range of brilliant metallic shades. With the exception of subdued specialty shades, the color pigments should be as brilliant, transparent, and non-flatting as possible. By selection of proper pigments in the range of yellow to orange, various shades of gold are produced.

The so-called **bronze** pigments are in many ways similar, except that copper alloys are used in their production. Copper bronze consists of substantially pure copper, while gold bronzes are alloys of copper, zinc, and a very small amount of aluminum. The effects of particle size are similar to those described above. Generally, these bronzes produce shades of gold much brighter than the corresponding hues made with aluminum pigment and transparent color pigments; because of their higher specific gravity the bronzes show less coverage on a weight-for-weight basis.

Shading of bronzes is possible by blending various alloy powders, providing the particle size is small enough that individual particles of different shades do not show up in the finished goods. Shading of bronzes by the use of transparent pigments is not recommended because inordinately large amounts of shading pigments are needed to produce a small color change, and brilliance is generally impaired. This is because bronze flake reflects light in a fairly narrow range of wave lengths and, therefore, further modification by absorption of light is not very effective. In the use of bronze pigments, extreme caution is indicated whenever permanence to heat, light, oxidation, or other chemical influences is required. Frequently, combinations of aluminum and transparent color pigments will be found preferable for this reason.

Pearlescent pigments

While the metallic pigments consist of completely opaque flakes, pearlescent pigment particles are essentially transparent crystals of a high refractive index. The optical effect is one of partial reflection from the two sides of each flake. When reflections from parallel plates reinforce each other, the result is a silvery lustre.

The decorative importance of pearlescent pigments is twofold: 1) They provide a brilliant lustre without hiding the underlying surface completely. Effects possible range from brilliant highlighting to moderate enhancement of the normal surface gloss. 2) Pearlescence provides a virtually opaque brilliance. Here the superiority of pearlescent over aluminum pigment lies in the white "silveryness" of the former; compared to this, even the best aluminum effect looks grayish. However, pearlescent materials are very much more expensive than aluminum, because of their low opacity, and will be used only when absence of grayness is essential.

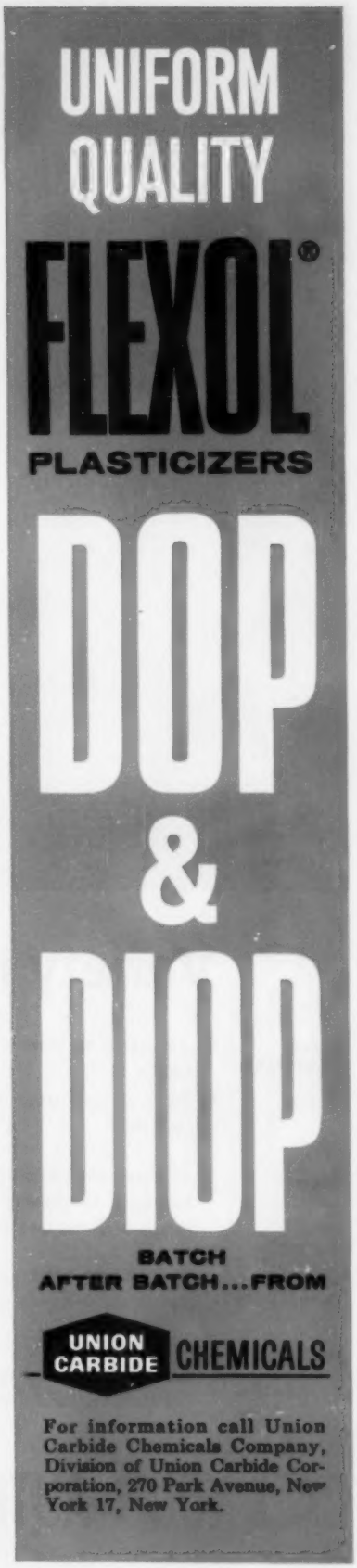
Because of their transparent nature, pearlescent pigments are readily modified by inclusion of color pigments. In almost every case the color pigments used should be the brightest and most transparent ones available. The use of even small amounts of opaque pigments results in considerable dulling of brilliance; and use of transparent color pigments of low brightness will often produce an effect which could be more economically attained by the use of aluminum flake.

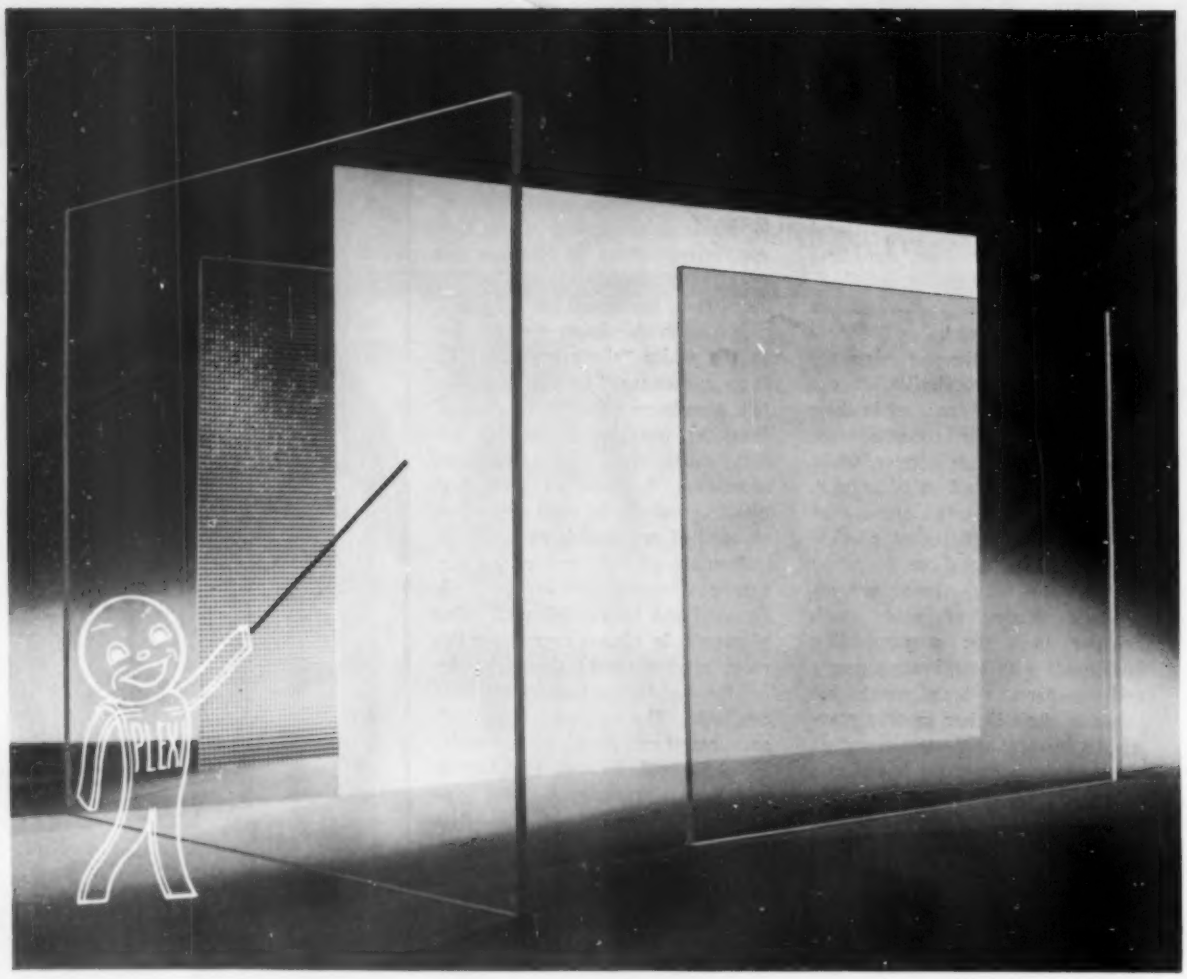
Pearlescent pigments are available in a variety of types.

1) Natural pearlescence is a guanidine crystal obtained by the washing of fish scales. It is extremely high in brilliance and light fastness, and moderately high in heat fastness. Being considered non-toxic, natural pearl is used in cosmetic applications. It is, however, extremely high in price and, therefore, limited in use.

2) Lead carbonate crystals comprise a series of pearlescent pigments ranging in brilliance from moderately high to extremely high. Price is largely dependent on the brilliance, and it is very much lower than that of natural pearlescence. Lead carbonate pearls show a very high heat and light fastness but they blacken very badly under the influence of hydrogen sulfide and similar compounds. For this reason, as well as because of possible toxicity, applications are also limited.

3) Lead phosphate and **4) lead arsenate** are other compounds which can be produced in the form of pearlescent crystals. Their bril-





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liance is considerably lower than that of even the least brilliant commercial grade of lead carbonate, and they are somewhat lower in price. Lead phosphate suffers from the same lack of sulphide resistance as does lead carbonate. It is used mainly where a somewhat opaque effect is desired. Lead arsenate is quite good in its resistance to sulphide discoloration; however, in considering it for any proposed application, regardless of any arguments that may be advanced concerning its insolubility (and, therefore, relative harmlessness) the psychological effect of the words "lead" and "arsenic" on consumers must be considered.

5) Bismuth oxichloride pearlescent pigments are priced higher than the average grade of lead carbonate and possess a brilliance higher than all but the costliest of the recently developed lead carbonate pigments. Even aside from their insolubility, they can be rated only slightly to moderately toxic because of the absence of lead salts. In addition, they show much less darkening under the influence of hydrogen sulphide than does lead carbonate. However, bismuth oxichloride pearls are very poor in resistance to light. Some progress has been made in recent years toward overcoming this defect, but even at present none of these materials can be considered an outdoor pigment.

Glitter

A final group of materials which deserves mention is the class variously known in the trade as **flitters, glitters, spangles,** etc. These are flakes large enough so that each separate flake produces a plainly visible sparkle or reflection. Various manufacturing procedures are used, producing materials of the following two types: 1) a very thin flake of random shape in aluminum or any of the bronze shades, generally available in sizes ranging from approximately 0.05 to 0.01 in. in average diameter, with average thickness much below 0.001 inch; and 2) flitters made by cutting out a bright sheet material, generally aluminum foil or metallized plastic film. The regular geometrical shapes obtainable include circles, rings, squares, rectangles, and hexagons. The thickness varies with the manufacturing procedures involved. Both the cost per pound and, especially, the mileage obtainable with this are much less favorable than that of the random-shaped glitter flakes. However, the additional expense is often justified by the eye-catching effect of the regularly shaped particles and the much wider range of color effects obtainable. Flake sizes generally range from 0.015 to 0.125 inch. Full range of color coatings or laminations can be applied to the foil or metallized film to produce brilliant metallic colors and a range of golds and coppers. Transparent flakes of a brilliant iridescent effect are also available.

In order to utilize fully the esthetic potential of the specularly reflecting flake pigments, their characteristics must be taken into account both in *design* and *production* of the plastic. These conditions should be considered separately for the two major techniques, surface coloring and integral coloring.

Surface applications

In the surface application of specularly reflecting pigments, the highest degree of brilliance is obtained when all pigment flakes are as closely parallel to the surface of the object as possible. There are several ways to do this.

The majority of metallic pigments carry on their surface a coating of stearic acid or similar material that resists wetting in many types of vehicles. As a result, the non-wetted pigment flake is carried to the surface of the paint film. When this process, called "leafing," is permitted to occur by proper choice of pigment, vehicle, and process, a coating of mirror-like reflectance results. However, since the pigment is loosely bound to the underlying varnish layer and unprotected by overlying varnish, the finish is frequently susceptible to crocking (*i.e.*, to rubbing off).

Several circumstances contribute to the diminution or absence of leafing, notably the replacement on the metal pigment of stearic acid by lubricants (*e.g.*, oleic acid) and the use of solvents which decrease the leafing effect of the lubricant.

Under the right conditions even a non-leafing metallic pigment will produce well-oriented coatings of good brilliance. This is promoted by the use of a vehicle of low solids content, orientation occurring

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upon shrinkage during drying. The pigment should be of the largest flake size which can be used without interfering with the particular process involved. The coating must be completely free of darkening, opacifying, and flatting materials. These three types of material, however, are frequently added to obtain special effects other than ultimate brilliance (*e.g.*, very dull brushed finishes from flatting agents; antique effects from dark pigments; or diffuse semimetallic colors from opaque hues).

With decreasing orientation of pigment particles, appearance of the coating is increasingly influenced by particle size, and may range from a smooth brushed appearance with the smallest particles to a much more brilliant but broken-up effect for the larger flakes. The various types of glitter pigments provide a maximum contrast between a very bright highlight and the more subdued surface.

Pearlescent pigments, due to the nature of their optical effect, are completely dependent on orientation for their effectiveness. In a metallic, which is opaque, the first or top-most flake struck by light in any area produces the total of the effect observable (Fig. 2, p. 94). However, since the pearlescent pigments are largely transparent, the effect from any particular area is the sum of all the minor reflected rays from the pigment flakes "stacked" in that area (Fig. 3, p. 95). Therefore, a slight disturbance in the parallel orientation of the pigment flakes may cause the loss of much or most of the pearl effects. Since pearlescent pigments in general have no leafing properties, the orientation must be obtained by proper choice of vehicle, as outlined above. The overall effect is greatly dependent on the color of the substrate. Generally the unique properties of pearl are best utilized by application over a white or pastel substrate or over a bright saturated color.

To obtain a degree of three-dimensional quality, metal- or pearl-pigmented coating can be applied to an embossed surface (*e.g.*, concentric slanted grooves will exhibit highlight patterns which shift as the observer moves).

In connection with this subject of imparting surface brilliance to plas-

tic articles, we should mention two treatments which are not pigment applications in the strict sense of the word. The first is vacuum metallization. The second consists of rubbing the plastic article with bismuth oxichloride powder or similar material. Due to its soft lamellar structure and high refractive index, this material leaves the surface coated with a transparent brilliance somewhat akin to the optical effect of pearl pigments. The most common use of this process is in the production of iridescent finishes. In this process, the bismuth oxichloride rub of the surface is followed by coating with an extremely thin transparent lacquer. Interference effects between the light reflected from the two surfaces of the lacquer film produce brilliant complementary color areas much the same as those seen in a soap bubble.

Integral coloring

When specularly reflecting pigments are used in the integral coloring of plastics the unique optical properties of these two materials are combined to produce a wide and unique range of effects.

The most obvious effects are those in which the pigment is kept as nearly parallel to the surface of the plastic article as possible, as in Figs. 2 and 3. In other words, when a two-dimensional, or surface brilliance, effect is desired, integral coloring is generally chosen instead of surface coloring because of process economies or similar reasons. The necessary orientation is achieved by various means. In the case of extrusion or calendering of sheet materials, orientation is a natural consequence of the process, due to the flow of plastic while in a viscous state. In some of the processes which cast the plastic in a liquid non-viscous state, orientation must be introduced by other means. In monomer casting, for example, the mold is frequently compressed after the materials have been set; in the case of plastisols, press polishing of the cured plastic is effective. This method also enhances the orientation in the case of calendered or extruded materials. We should emphasize again that while a certain amount of disorientation may be tolerated in metallics (particularly with larger particles) pearlescent materials must be oriented to the highest degree in order to achieve the intended effect.

Much more varied and interesting effects than those possible by means of simple parallel orientation are obtained by orienting the flake pigment at an angle to the surface of the plastic and varying this angle according to a set pattern. If the individual pigment particles are too small to be seen, then the eye interprets the oriented reflection as a solid surface, and, therefore, the effect in many cases is one of a deeply convoluted metallic or pearlescent surface beneath the clear surface of the plastic. By this means, a very thin plastic sheet may be made to produce the effect of a ¼-in. convoluted overlay. Among the methods available for producing this type of effect are the following:

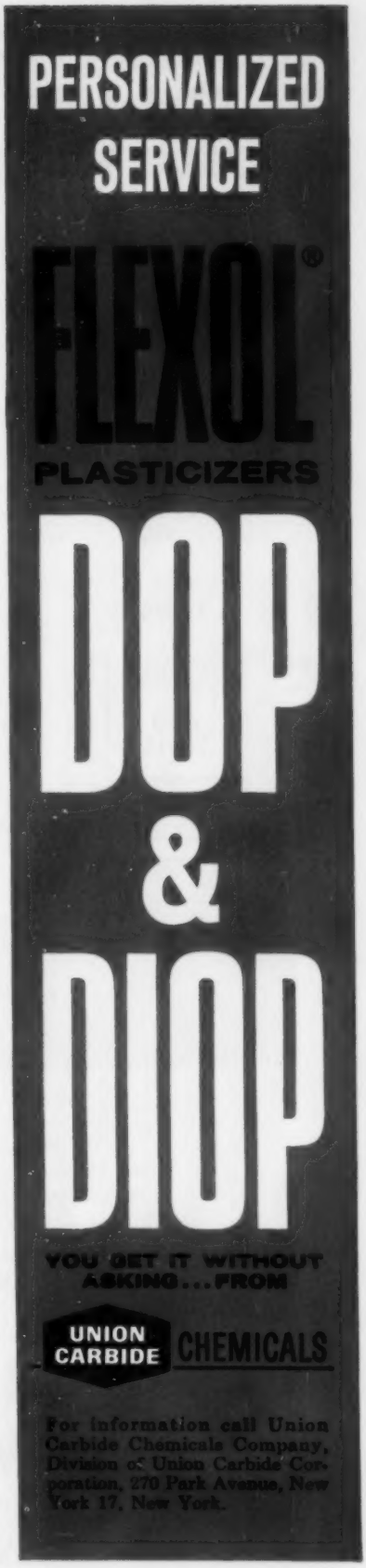
1. Deep embossing of the plastic followed by flatting under suitable temperature and pressure to eliminate the original embossed surface without destroying the resulting orientation pattern.

2. Stacking of oriented plastic pieces, such as extruded rods, at varying angles to each other, followed by compression of the whole into a block. This is then planed-off at the desired thickness, producing a sheet of moderately controlled orientation pattern.

3. Molding of randomly oriented plastic pieces into sheet or other form by compression. The result is a pattern which is uncontrolled except for the size and degree of flow of the individual pieces.

Metallic glitter particles suspended in a clear plastic lend a feeling of depth by their presence alone. Frequently they provide the best highlights when used in a non-oriented fashion (Fig. 4, p. 95), providing quick brilliant flashes as the object is turned or the observer moves in relation to it. Another combination suggests itself: a small amount of transparent coloring material will tend to partially hide the more deeply embedded glitter particles and lend a feeling of depth.

By the creating of new decorative effects with color, and particularly by the introduction of depth and the changing reflection as a result of movement, these new pigments can truly be considered to have added new dimensions to plastics design.—**End**



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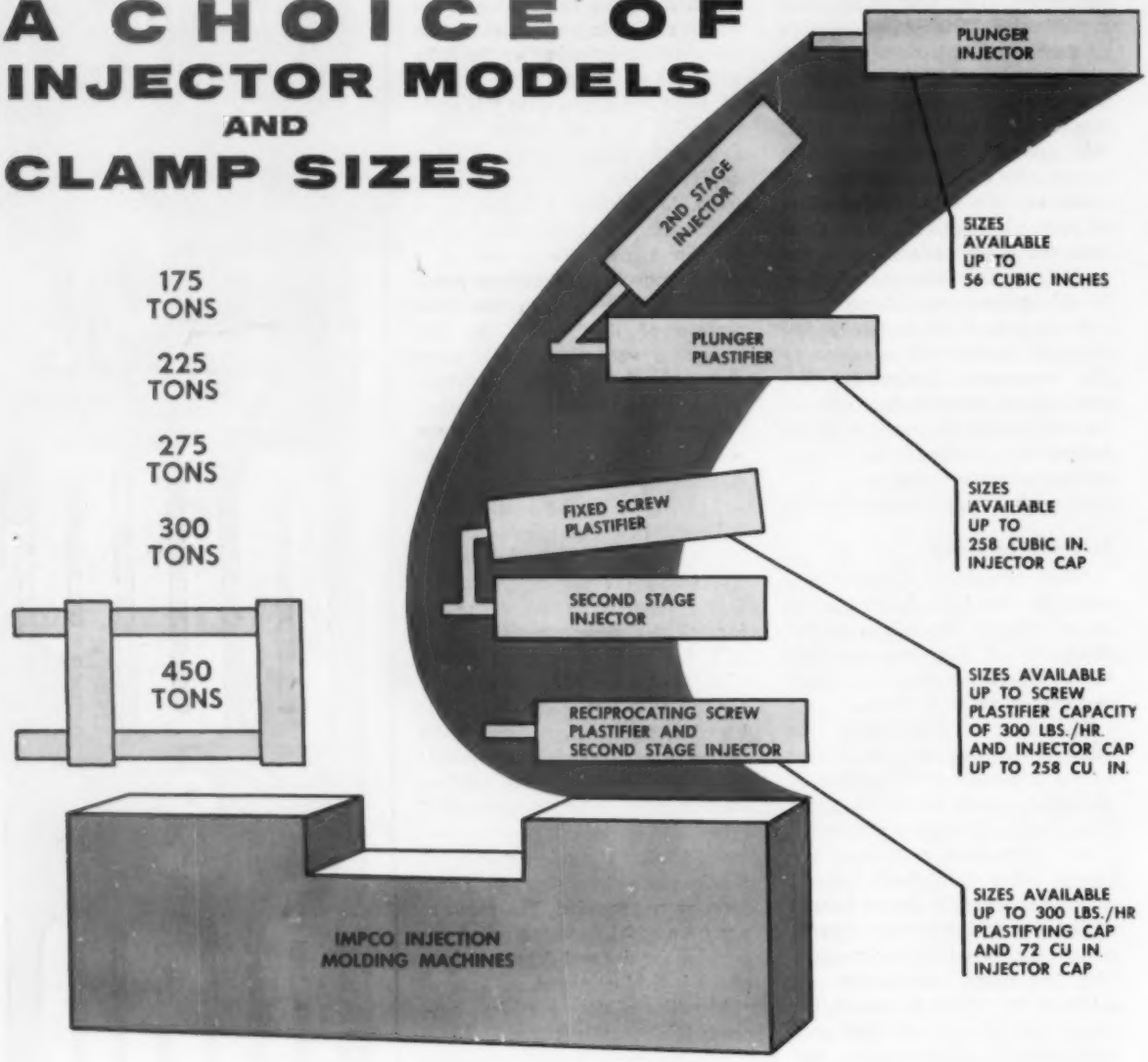
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Coatings for acetal

(From pp. 97-106)

air velocities of 100 to 200 ft. per min. provide adequate exhaust.

The treating formulation will retain its effectiveness over an extended period of time if the dip tank that is used to contain it is carefully designed to avoid exposure of the formulation to strong air drafts, which increase vehicle evaporation losses, and if the tank is provided with a reflux condenser of adequate capacity to trap and recycle evaporating vehicle. Normal vehicle evaporation losses, which can usually be kept below ½ pt./sq. ft. of dip tank area per 8 hr., may be replaced by periodic additions of the pure liquid vehicle. Since formulation entrainment on treated articles also removes small amounts of non-volatile, active ingredients, it will be necessary to replace these periodically as well as to maintain constant composition in the dip tank. Some experimentation may be required initially to compensate exactly for these losses and develop proper addition schedules.

Surface quality

The treated surface is characterized by a uniform distribution of microscopic, sharp, rough, irregular peaks and valleys which provide the anchor points for mechanical bonding. Photomicrographs of the surface profile are shown in Fig. 2, p. 98. It is the sharpness of the roughness of the treated surface that distinguishes it from those roughened by other chemical or physical methods. To the naked eye, the surface has a satin texture; and light at low incident angles is reflected in a specular pattern to provide the effect above.

Specular gloss and surface roughness correlate with the strength of the bond between the coating or adhesive and the resin surface in unpigmented materials. These properties furnish convenient nonfunctional measures of surface quality. Specular gloss is measured according to ASTM D1223-52T, using the Gardner Glossmeter.[3] Working standards are clean, polished black glass having a specular gloss of about 100 (up-scale standardization) and a dull-white tile with a gloss of 40 (down-scale linearity check). Gloss readings are reported in units relative to these standards. While maximum gloss readings for good adhesion differ for various thermoplastics, readings of no more than 60 on the Gardner 75° Glossmeter are preferred to assure satisfactory results.

Average roughness is the arithmetic average deviation from the peaks to the valleys in the treated surface. This property is measured with a Surfindicator.[4] Average surface roughness values are reported in terms of μin. (microinches or millionths of an inch). As a general rule, it should be noted that roughness greater than 20 μin. is desired for proper surface quality and good adhesion.

Controlling the chemical action to produce desired roughness requirements is not difficult. For many coatings, such as an undercoat for a metallized finish, light but uniform roughness is desirable. For others, such as low-gloss interior automotive finishes, greater roughness may be required. The formulation and process may be controlled by adjusting the active agent concentration and by adjusting exposure time in Steps 1 and 2. Therefore, roughness values are precisely reproducible within a range of 5 to 10 μin. And the result for any given set of conditions will, of course, also depend on the resin's inherent chemical and physical interaction with the treating formula used. Table II, p. 101, and III, p. 104, illustrate the effects of time and temperature conditions necessary to attain various degrees of roughness, with each of two fixed formulations. A comparison of the tables also reflects the effect of increasing the concentration of the active agent (p-toluenesulfonic acid) in the treating formulation. (See footnote to Table III. Note the increase in roughness with the increase in acid).

Many types of finishes may be firmly bonded to treated surfaces. Finishes include: nitrocellulose and acrylic lacquers; and alkyd, polyurethane, epoxy, and phenolic enamels. These paints may be of the normal commercial quality that are formulated for interior or exterior automotive and appliance service applications. The high heat resistance of acetal **(To page 190)**

[3]Portable, 75°, angle-type made by the Henry A. Gardner Laboratory, Bethesda, Md.

[4]Model BL-110, made by Brush Instrument Co., Cleveland, Ohio.

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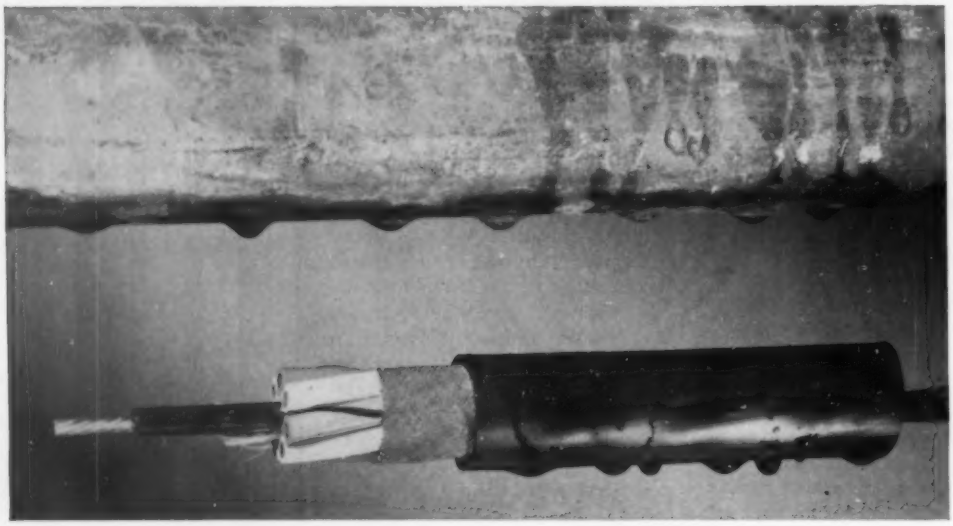

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RESINS SELECTOR. A 6-page fold-out brochure describes and gives a revised guide to the selection of insulating resins. Includes physical, mechanical, thermo and electrical properties for each resin system discussed. Marblette Corp. **(101-L)**

SURFACTANTS. 5-page technical bulletin describes three glycerol tallate surfactants including high, medium and low monoesters, for use as emulsifiers, detergents and lubricants. Includes a wide list of suggested applications and gives formulas plus other data. Kessler Chemical Co., Inc. **(102-L)**

TEST EQUIPMENT. An 11-page booklet illustrates and describes custom-built production chilling and environmental test equipment for plastics and other products. Includes pressure, temperature, and conversion chart in addition to other data. Cincinnati Sub-Zero Products. **(103-L)**

TESTING EQUIPMENT. Illustrated 30-page catalog describes a line of physical testing machines for plastics featuring electronic loading, weighing and instrumentation. Tension, compression and flexure testing. Tinius Olsen Testing Machine Co. **(104-L)**

ROLL LEAF. 4-page folder describes a line of roll leaf for the plastics industry. Includes use and process data. Admiral Coated Products, Inc. **(105-L)**

FOAM MACHINES. Assorted data sheets describe a line of foam machines with capacities from 8 pounds a minute to 100 pounds a minute. Each sheet includes specifications and other data. Gabriel Williams Co., Inc. **(106-L)**

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INJECTION MOLDING MACHINES. A 9-page booklet describes "Ratothrust" injection molding machines of single screw design. Includes illustrations and description of features and other data. Peco Machinery Sales Ltd. **(111-L)**

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EXPANDED POLYSTYRENE. A 10-page booklet describes expanded polystyrene foam plastics, foam-molded board and molding machinery and cutting equipment. Includes discussion of manufacturers' facilities and other data. Dura-Tech Corp. **(113-L)**

TETRAHYDROFURAN. A 13-page booklet describes in detail the properties and uses of a tetrahydrofuran. Discusses its use as a solvent coating and other applications. Electro Chemicals Dept. E. I. du Pont de Nemours & Co., Inc. **(114-L)**

PLASTICS DESIGN. An 11-page brochure describes an integrated plastics molding service which includes design, engineering, mold building, etc. Discusses typical parts and product design. American Insulator Corp. **(115-L)**

EXTRUDERS, GRANULATORS & AUXILIARY UNITS. Booklet describes equipment for fully automatic plastic extrusion systems—including double screw extruders, granulator units, pipe extrusion heads, etc. Anger Plastic Machines Ltd. **(116-L)**

COLORS AND PIGMENTS. An 11-page brochure describes cadmium pigments and inorganic and organic colors for plastics and other products. Gives physical data tables and other information, plus price list. Kentucky Color Div., The Harshaw Chemical Co. **(117-L)**

BETA GAUGES. A 32-page book illustrates and describes a line of beta gauges —instruments for measuring continuous sheets of plastic, etc. Includes specifications, accessory units and a guide for selecting a gauging system. Tracerlab, Inc. **(118-L)**

POLYETHYLENE RESINS. A 4-page folder describes two intermediate density polyethylene film resins for use in overwrap and sheet applications. Includes table of properties and other data. The Dow Chemical Co., Plastics Dept. **(119-L)**

SILICONES. A 15-page booklet describes and discusses a line of silicones and their application in a variety of products and operations. Includes typical physical property tables and other data. Silicone Products Dept., General Electric. **(120-L)**

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FLOW INSTRUMENTATION. Technical bulletin illustrates and describes a line of instruments for flow measurement and control. Contains complete listing of specifications and other data. Brooks Instrument Co. **(127-L)**

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INJECTION MOLDING MACHINES. Illustrated specification sheet describes injection molding machine that offers 6 to 10 ozs. shot weight, 900 to 1050 cycles per hour dry run, and plasticizing capacity of 100 lbs. per hr. etc. General information, specifications, other data. The Fellows Gear Shaper Co. **(138-L)**

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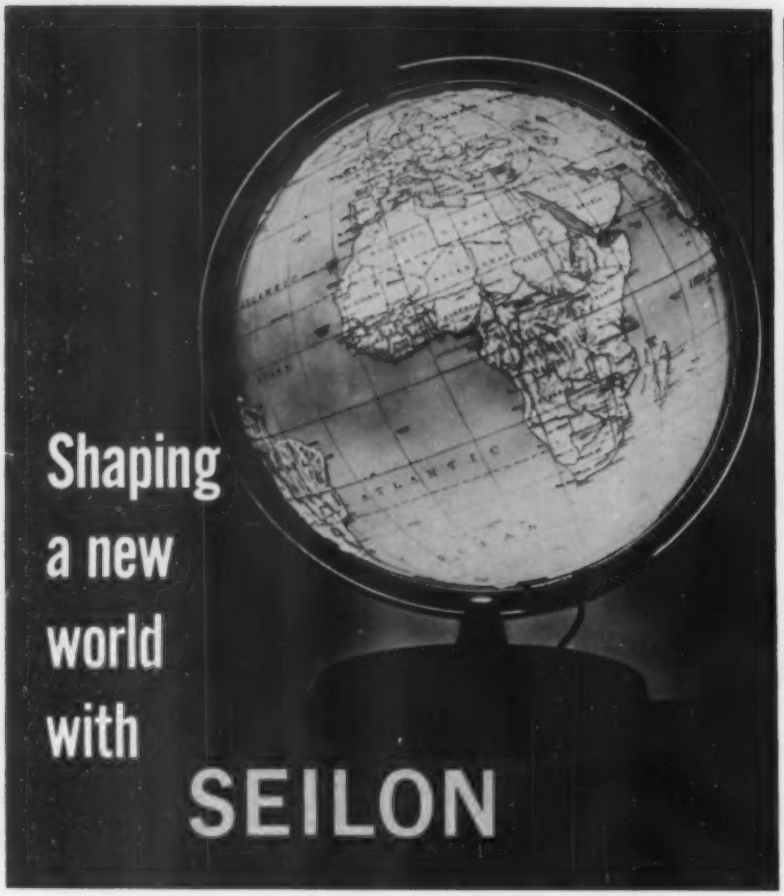

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resin makes it possible to bake painted surfaces at temperatures normally used for metal finishes. Therefore, acrylic lacquer or alkyd enamel can be baked on acetal at a temperature as high as 290° F. without harming the resin.

Any of the functional industrial tests for coating adhesion may be applied to treated surfaces that have been prepared by this process. A simple qualitative evaluation is the Scotch Tape[5] test.

In this test the coating is scored by cutting through the paint film in two series of obliquely intersecting parallel lines about 1/16 in. apart. This results in a pattern of small diamonds.

Tape is pressed on the scored area and quickly peeled off. Adhesion is judged by the amount of paint removed. A more stringent test is to apply the Scotch tape after oven-aging the coating 16 hr. at 250° F. Painted articles of treated Delrin acetal resin pass these tests, as well as the tape test, after 100 hr. exposure to 100° F. and 100% relative humidity.

Adhesion and retention of color and gloss are also excellent after accelerated weathering tests, as is indicated by the data found in Table IV, p. 104.

In gravel impact tests, treated acetal resin painted with automotive finishes outperforms painted steel surfaces which have been treated with Bonderite[6] No. 100 and primed, as shown in Fig. 3, p. 101, as well as in Table IV, which illustrate the paint erosion resulting from the tests.

The mechanical properties of the resin are essentially unaltered by the treatment, as shown by the results in Table V, p. 106.

Occasionally, molded parts may contain inserts of other materials such as stud bolts or attached wiring. Experience indicates that materials such as Neoprene rubber, cadmium-plated steel, wrought iron, zinc, mild steel, and stainless steel are not affected by this Satinizing treatment.

Specific applications

The foregoing discussion has outlined the basic treating formulation, process variables, and results. The examples summarized in Table VI,

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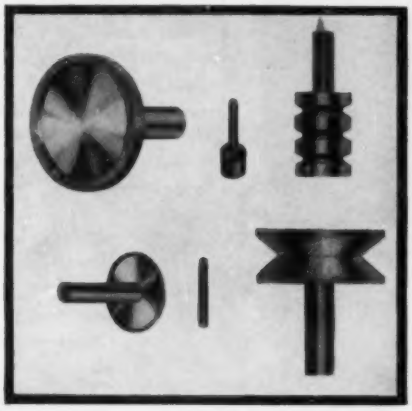

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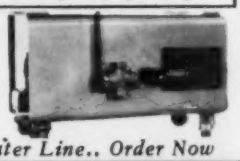

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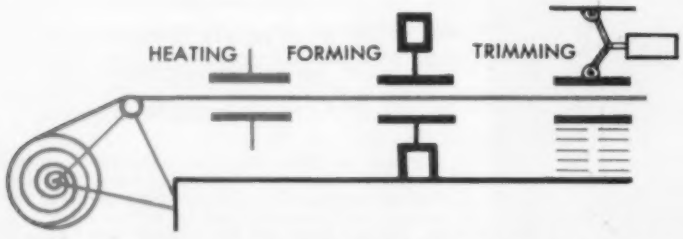

The 621 operates from roll stock and will handle any thermoplastic material sheet-thickness which can be supplied in roll form. The trim press can be installed in the machine so parts can be trimmed either up or down, through the open platen. Rule type dies may also be used.

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p. 106, illustrate these process features more specifically.

In each of the five examples that are given, panels of Delrin 500 NC10 acetal resin were treated. In addition, in Examples 2 and 5, panels of nylon resin (Zytel 101 NC10) were used.

Only conditions for the dipping and air-exposure reaction operations are shown. Conditions of water rinse and water drying were virtually the same in each case: panels were rinsed with hot water (cold water was used in Example 5) and then air-dried.

Surface roughness in each case was measured by the Surfindicator. Glossmeter data shown in Examples 1, 2, and 4 were obtained with a 75° Gardner Glossmeter.

The formulation and process conditions outlined in Examples 1 and 2 are recommended for general use in treating molded articles of Delrin and Zytel prior to painting. For articles that are made of these plastics materials which are to be metallized, the formulation and conditions outlined in Example 3 are recommended.

All five formulations and process techniques produced surfaces which could be satisfactorily bonded with adhesives, but those used on Examples 1, 4, and 5 appear to be particularly good for preparing surfaces for adhesives. Treating formulations in Examples 4 and 5 used tap water instead of perchlorethylene as the vehicle or solvent.

Because acetal resin competes mainly with metals, the Satinizing process can be expected to enhance its economic and technical advantage over metals in many cases. The ability to make excellent adhesive joints also broadens the horizon of new applications by providing more product design freedom and possible combinations with other materials. Finally, the new process, in addition to sharply reducing finishing costs (by eliminating primer coats and rejects), makes it practical to employ assembly-line finishing techniques with moldings of all shapes and sizes. For example, the Stimsonite Div. of Elastic Stop Nut Corp., Chicago, Ill., is now using this surface treatment process in producing an auto air conditioning grille for John E. Mitchell Co., Dallas, Texas (See Fig. 4, p. 104).—**End**

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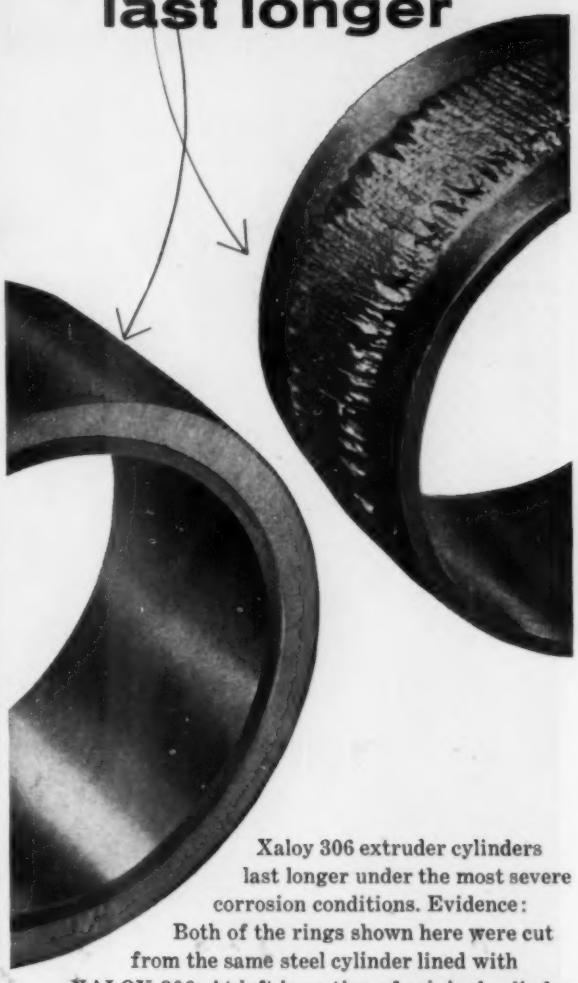

Xaloy 306 extruder cylinders last longer under the most severe corrosion conditions. Evidence: Both of the rings shown here were cut from the same steel cylinder lined with XALOY-306. At left is section of original cylinder with XALOY-306 lining. At right is section from same tube after immersion in boiling 50% hydrochloric acid. Note that Xaloy-306 lining is unaffected while steel backing has almost completely dissolved.

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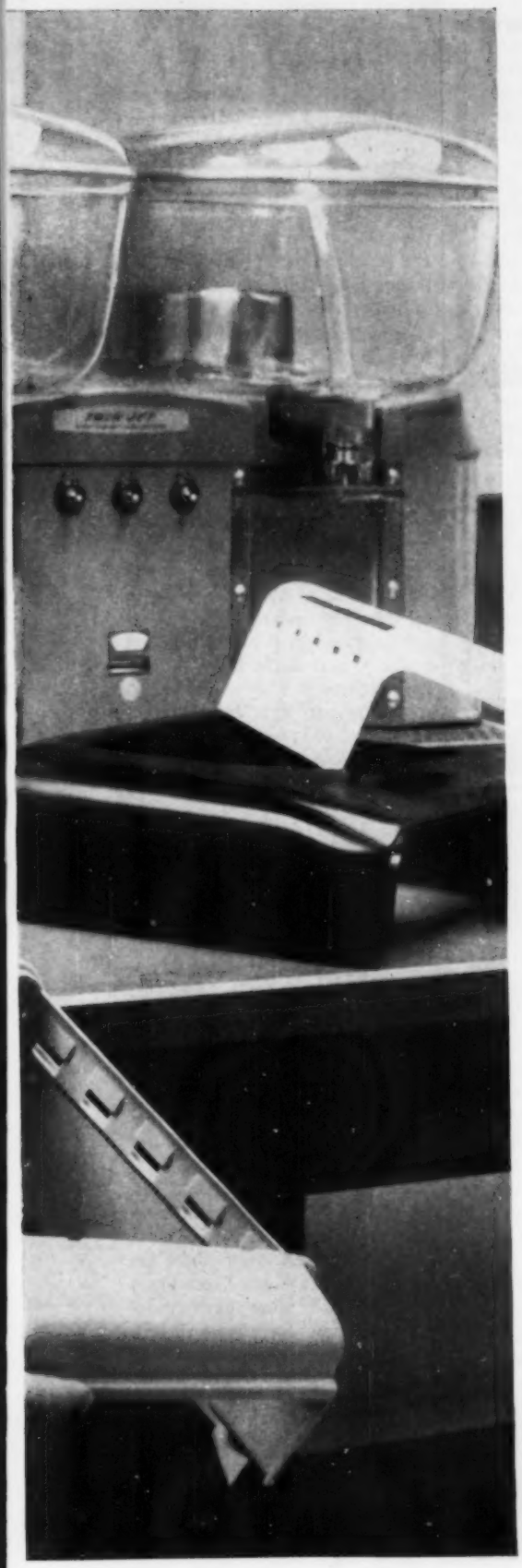

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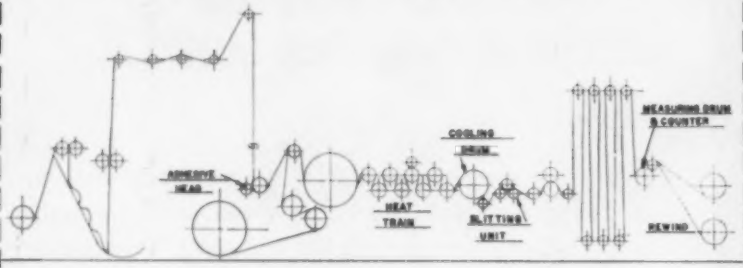

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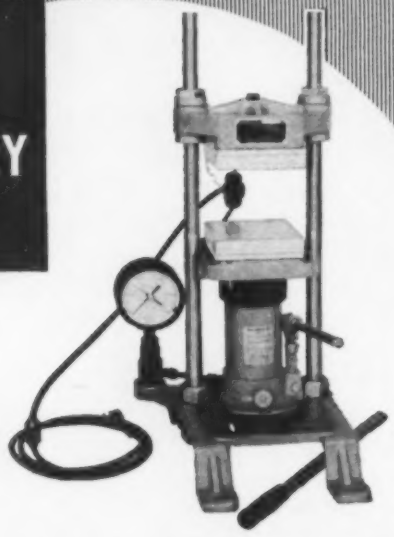

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Mold design

(From pp. 113-114)

thickness of cavity wall so that heat may be transferred quickly and uniformly to all areas in the cavity. Two separate machining operations are required, one for the cavity and one for the steam side. In casting, once patterns are made, both cavity and steam side are produced simultaneously and only finishing is required on the cavity.

However, there are disadvantages to casting. In casting there is always the risk of forming gas pockets or voids under the surface of the mold which will appear when the surface is finished or polished. These necessitate costly repair or rejection of the casting. The gas bubbles can be caused by moisture in the pattern sand or plaster. In addition, sand-cast surfaces are generally rough and difficult to polish, requiring a considerable amount of buffing or even machining. Advanced casting methods such as the Shaw process will produce a usable surface, as cast. However, even these surfaces are not as good as those obtained on molds cut from mill shapes of aluminum machining alloys. Because the machining alloys usually have a finer grain and texture, they take a better polish, which results in mold cavities which are less likely to cause sticking of the parts.

Another disadvantage of using casting to produce aluminum molds is that mold walls must be made thicker to allow free flow of the molten aluminum during pouring. Cast wall sections in large molds must be at least ¼ in. thick; often, ⅜ in. is required for a good casting.

Another disadvantage of casting is the fact that, even for identical cavities, each cavity to be cast will require a new sand pattern. Thus, excepting for the cost of the master pattern, the unit cost per cavity is fixed. Of course, except where the cavities may be hobbed, machined molds suffer the same disadvantage.

Nevertheless, for almost all jobs needing only a moderate number of cavities, casting provides the lowest initial cost per cavity. However, when long production runs are anticipated, this initial cost advantage is often nullified through use of faster-cyling, more costly molds.

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may be built up from sheet and mill shapes or cut from blocks. When fabricated from soft metal such as aluminum sheet, care must be taken to back up the sheet to provide adequate mold strength and rigidity to prevent distortion in operation.

Welding is commonly used for assembling built-up molds. In welding, great skill is required to avoid setting up significant internal stresses in the metal, which can cause problems in mold operation. These stresses, usually not apparent in the cold mold, can cause significant dimensional changes when the mold is suddenly raised from 60 to 230° F. during the cycle. Such dimensional changes in turn will distort the molded part. Where cast and fabricated sections are combined, extreme caution must be taken in welding to prevent internal stresses. Such molds have burst at the seams under sudden temperature changes. Molding pressure exerted by the expanding beads combined with the temperature shock will accelerate the failure of a badly welded mold.

Spinning and **hydroforming.** Spinning (Fig. 12, p. 114) is obviously limited to cavities with geometries corresponding to solids of revolution, *e.g.*, shapes which may be formed on a lathe. On the other hand, hydroforming may be used for complex and irregular shapes.

Hydroforming is similar to metal stamping or hobbing. The master pattern, like a hob, is a male force and is the image of the female cavity. The master pattern is forced into the metal sheet to be formed, while the underside of the latter is usually supported by a rubber pad. (See Fig. 13, p. 114.)

Using either method, a master—usually of metal, sometimes of hard wood—is required. The master pattern or die for hydroforming can cost thousands of dollars; the cost of a die or master for spinning will run to a few hundred dollars.

These methods are normally used in the production of cavities of stainless steel and nickel. As mentioned, these molds are usually economical only for multiple cavities or for very long runs where the higher initial cost of the mold can be offset due to the production economies achieved using the faster cycling molds. If economics permit the use of such molds they are highly recommended.–**End**

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Static pressure

(From pp. 123-130)

would be obtained at static pressures down to the minimum value, the pressure drop at open discharge. Since, as we have observed, the *slope* of this line is independent of the choice of shear stress, the line may be used to calculate *ratios* of flows at pressures lower than the 800-p.s.i. drop associated with a stress of 10 p.s.i. By so doing, a curve representing the flow to be expected at open discharge can be constructed. This is the dashed curve that is evident at the extreme left of Fig. 5.

The answer to the question raised above now stands before us. Since in an extruder die or injection mold gate we *do* normally have open discharge, so that pressure drop and upstream static *are* identical, the flow rate to be expected at any given pressure drop must be found from the dashed line. And it is clear that this curve rises steeply and almost parallel with the solid lines. This curve approximates what Westover would have obtained if he could have measured flow rates at the chosen high pressures but with open discharge, *i.e.*, with single-piston measurements.

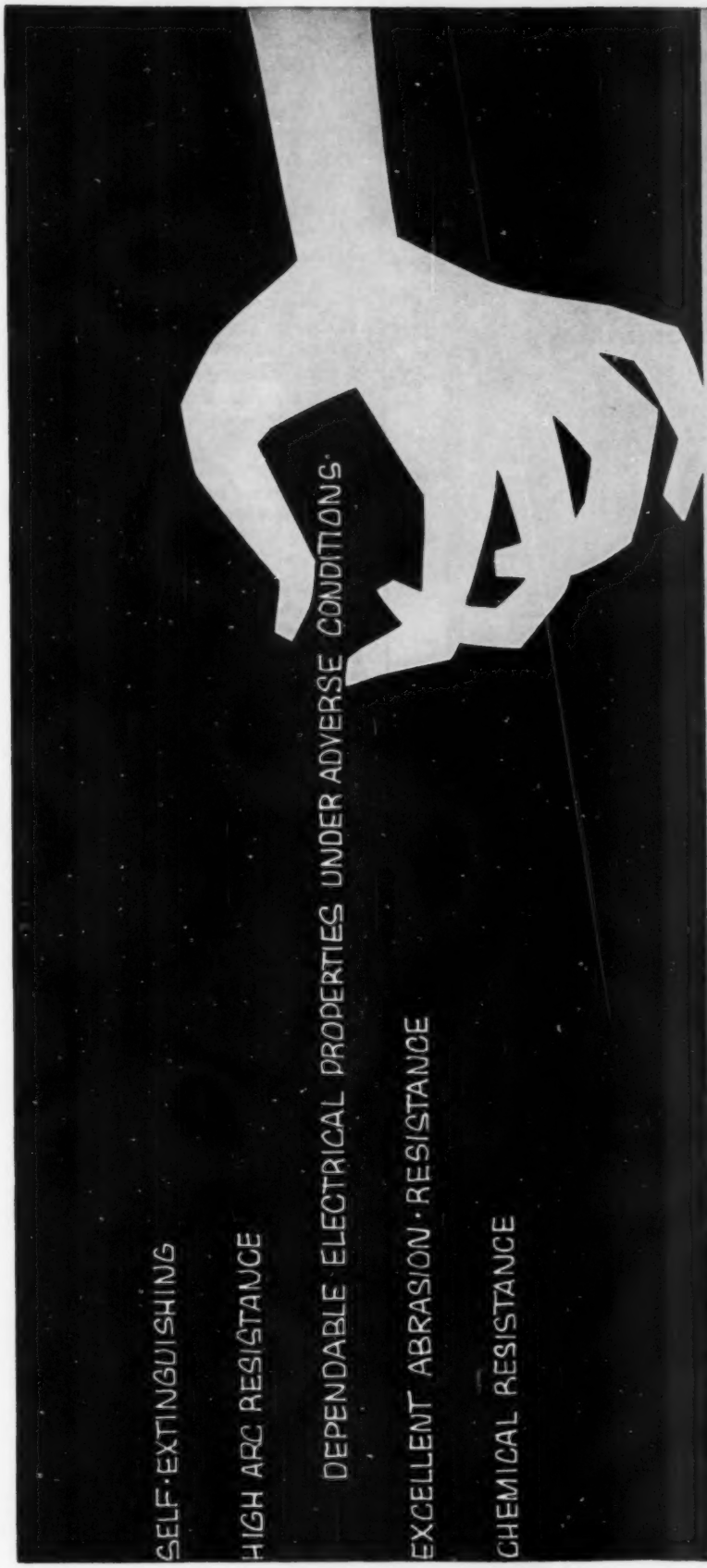
The pressure drops involved in getting these particular data did not exceed 2600 p.s.i., lower than many extrusion pressures and far below the injection-molding range. To gain at least a qualitative notion of what this picture looks like in the operating range, the data lines have been extended in Fig. 7, p. 128, to show the entire range of pressure drop, for all the static pressures investigated.[5] To make the picture a little more realistic, the abscissa of the plot has been altered to "uncorrected pressure drop," since it is actually the *uncorrected* drop that cannot exceed the static pressure. This was accomplished by increasing the available corrected-drop values by a factor of 1.5 to allow for the fact that most commercial dies and gates are shorter in relation to their diameters than Westover's 20-to-1 orifices.

Although the dashed line in Fig. 7 seems to curve more sharply at the very high pressures, two conclusions are clear: 1) Under normal commercial operating conditions, raising the extrusion or injection melt pressure of polyethylene will *always* result in an increase in flow. 2) Static pressure affects the flow of polyethylene much less than does pressure *drop*. For example, raising the static pressure from 5000 to 10,000 p.s.i. while holding the drop (uncorrected) constant at 2000 p.s.i. reduces flow by a factor of about 1.6, whereas raising the pressure drop from 2000 to 4000 p.s.i. at an upstream static pressure of 10,000 p.s.i. jumps flow rate up by more than 6-fold. While these figures are only examples, they are not unrepresentative of the polyolefins. As Westover's data show, the effect of static pressure is greater with polystyrene than with polyethylene; at shear stresses encountered in processing, however, pressure *drop* also affects flow of polystyrene more sharply than it does polyethylene, so the two factors are of about the same relative importance in polystyrene flow as in polyethylene flow.

In general confirmation of the pressure/viscosity picture is the close agreement between the results of Maxwell and Westover. As Fig. 3 shows, Maxwell obtained a 5.7-fold increase in apparent viscosity of polyethylene over the pressure range from 8000 to 26,000 p.s.i.; the average line of Fig. 6 shows that Westover found an average 5.6-fold increase as pressure rose from 5000 to 25,000 p.s.i. Over the 8000 to 26,000 p.s.i. range, Maxwell found that the viscosity of polystyrene increased 135-fold; Westover observed an equal increase over the range from 2000 to 25,000 p.s.i. This agreement on the magnitudes of the effects appeared in spite of substantial differences in temperatures and shear stresses.

Somewhat surprisingly, the pressure coefficient of viscosity is smaller in polyethylene than in the hydrocarbon oils investigated by Hyde. Probably this is an indication that it is the complexity of the small "flow unit" rather than the complexity of the whole polymer molecule that controls the magnitude of the pressure effect. These units are almost starkly simple in polyethylene. In polystyrene, conversely, each flow unit contains a dozen or so benzene rings that are

[5] New errors are introduced here. Heat effects, melt fracture, and shear degradation may all operate to alter the shapes of these graphs at highest shear stresses, but I doubt that they would change the qualitative picture.



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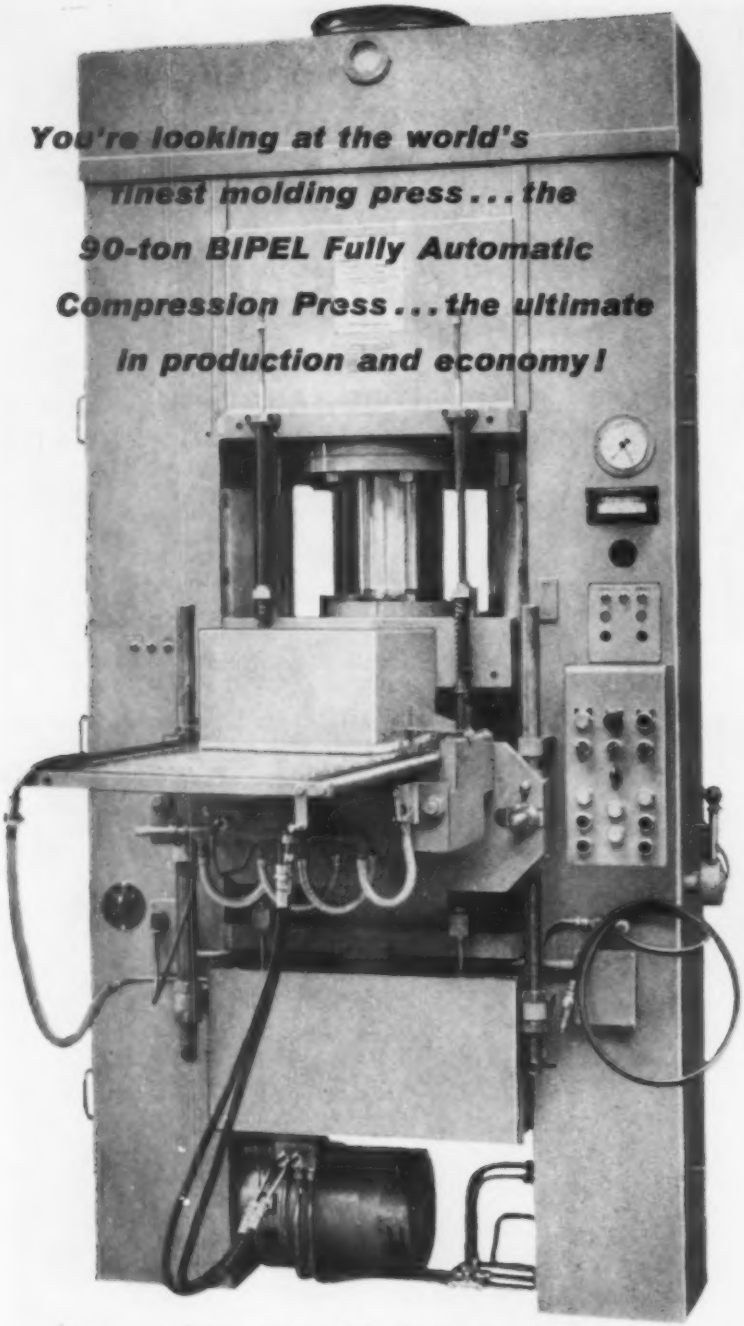
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dangling on the main chain segment, thereby making the unit a highly complex one. This complexity is reflected by the high pressure coefficient of viscosity.

An interesting exception to the above two conclusions can arise when the temperature is so low that under high static pressure the melt solidifies, wholly or partly. Both Maxwell and Westover noticed effects of this sort, in which the apparent viscosity climbs very rapidly as the transition occurs. The temperature must be fairly close to the normal softening range, however, since the rate of rise of melting point with pressure is very small. Such low temperatures at very high pressures are seldom encountered in commercial processing, so these transition-region viscosity phenomena are of more academic than practical interest.

Figures 5 and 7 also help to explain why the influence of static pressure is not observable in single-piston experiments. Two factors are at work here. The first is the relatively slight influence of static pressure on flow as compared with the big effects of temperature and pressure drop; static pressure effects are masked by the experimental error. For example, the difference in flow rates between 1) open discharge with a differential pressure of 3000 p.s.i. and 2) 5000 p.s.i. static pressure with the same differential is about 22%, only slightly more than the errors associated with the results of both Metzner *et al.* and Westover.

The second and chief factor working to hide the static-pressure effect in single-piston experiments is the inability to discriminate between effects of static-pressure and pressure drop on flow, mentioned earlier. While a *semi*-logarithmic relationship between apparent viscosity and static pressure is theoretically indicated, the *log-log* plot of static pressure versus shear rate for polyethylene at static pressures up to 20,000 p.s.i. is gently sloping and is linear enough so that no part of the curve differs from the line by more than 20 percent. For the system of plotting flow results in which shear stress is plotted as the ordinate versus shear rate, it is easy to show that the effects of this hidden log-log function would be to reduce the slope of the plot by

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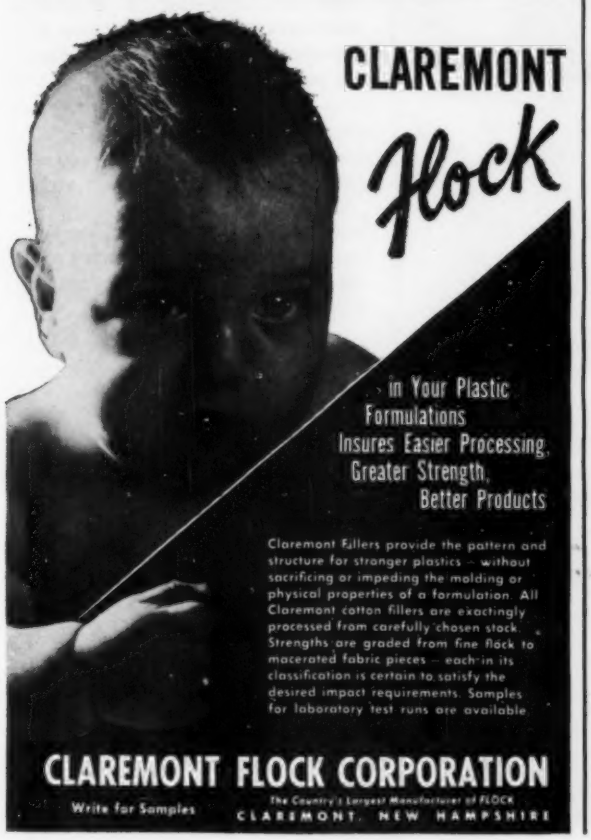
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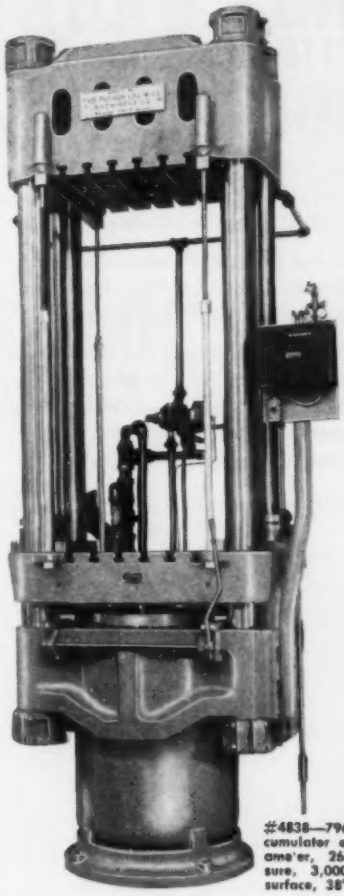

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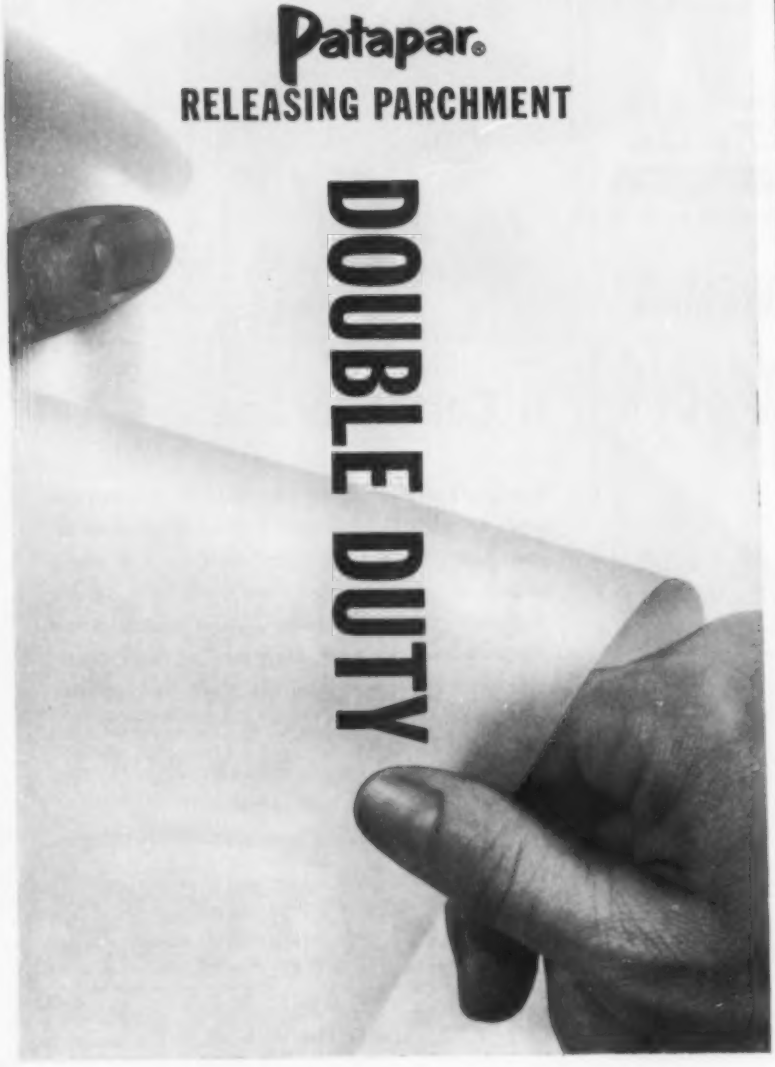

about 0.1 and to change the intercept some. Since the intercept value varies widely among resins, and since the plot usually curves with varying slope (from 0.51 to 0.27 in the case of Metzner's Fig. 2), these minor effects of static pressure could not be detected.

Metzner *et al.* also presented a linear-coordinate plot of uncorrected pressure drop versus L/D (Fig. 1 in Ref. 1), for six different apparent shear rates ranging from 2 to 1600 sec^{-1}. These plots all appeared to be good straight lines, and the authors concluded: "The absence of any systematic deviation of the data at the highest pressures . . . is proof that the changes in viscosity with pressure were negligibly small over the range of pressures studied, up to 19,000 p.s.i., for this material and temperature (160° C.)."

This seems convincing until one looks closely at the interrelationships involved. With branched polyethylene at shear stresses from 5 to 50 p.s.i., the apparent shear rate, $8\bar{V}/D$, is proportional to about the cube of the apparent stress at the tube wall. Thus the apparent viscosity, which is the quotient of stress and shear rate, is inversely proportional to about the square of the stress. In symbolic form this can be written thusly:

$$\mu_a \sim \left(\frac{\Delta P D}{4L}\right)^{-2} \qquad \text{Eq. 2}$$

Now, in the approximate log-log plot of apparent viscosity versus upstream static pressure mentioned above, the proportionality is

$$\mu_a \sim P^{3/2} \qquad \text{Eq. 3}$$

If we equate these two expressions for viscosity and remember that in open-end orifice work the pressure drop (ΔP) and upstream static pressure (P) are equal, the resulting proportionality may be solved for the pressure drop in terms of L/D to give:

$$\Delta P \sim (L/D)^{3/4} \qquad \text{Eq. 4}$$

Proportionality 4 indicates that if we replotted Metzner's Fig. 1 on logarithmic coordinate paper, we should expect to get a family of

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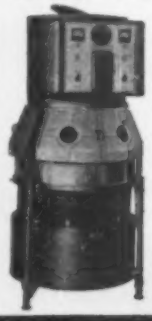

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straight lines with slopes of about 3/4. Such a plot is shown in Fig. 8, p. 130, and the slopes range from 0.74 to 0.84. Comparing this with the original version shows that both methods of plotting the data, in this case, give good straight lines; on a purely statistical basis it is doubtful which form fits the data better. While there are good, logical reasons for plotting as Metzner did, the linearity of his plots does *not* prove the absence of a static-pressure effect, any more than the linearity of these log-log plots, alone, proves its presence. But the overall effect is too closely confounded with that of pressure drop.

Whither polymer melt rheology?

Aside from the obvious necessity for gathering pressure/viscosity data on other plastics, this question remains: In double-piston work, what static pressure should be associated with the observed viscosity? Actually, a range of pressures and viscosities is involved unless the time scale is extremely short, so our choice of the upstream pressure is only approximate. Also, when entrance corrections are made, a part of the measured differential is subtracted. Should we not, perhaps, subtract this same correction from the upstream pressure, because one-directional flow does not commence until after the melt has passed the entrance?

These questions will remain unanswered until some rheologist devises a way of accurately measuring the static pressure at many points along the length of a relatively short (say 20:1) flow tube, for there is no way to reduce the differential pressure to a small value, say 10 p.s.i., and still obtain plastic melt flow that is representative of practical conditions.

One possible way around the difficulty is to use rheometers that achieve the shear by relative motion of their parts rather than by differential pressure. Most typical is the rotating-bob type. Of course, these instruments are not free of troubles, the worst being that at high shear rates the melt tends to climb out of the annulus between bob and cup (Weissenberg effect). There can be serious errors due to heat of viscous shearing, as in tube-flow rheometry. Also, it appears difficult to enclose such an instrument in a way that would permit applying high static pressures while making the rotational measurements. But if the mechanical problems could be solved, the rotational instrument offers two appealing advantages: 1) to a close approximation the entire melt is subjected to the same shear rate at any given speed and gap; 2) effects of static pressure on viscosity (and other rheological properties) could be measured at zero differential pressure, and the state of the melt could be definitely established. In addition, it appears to be easier to calculate the corrections for viscous-work heating in this type of instrument than it is for the tube-flow type.

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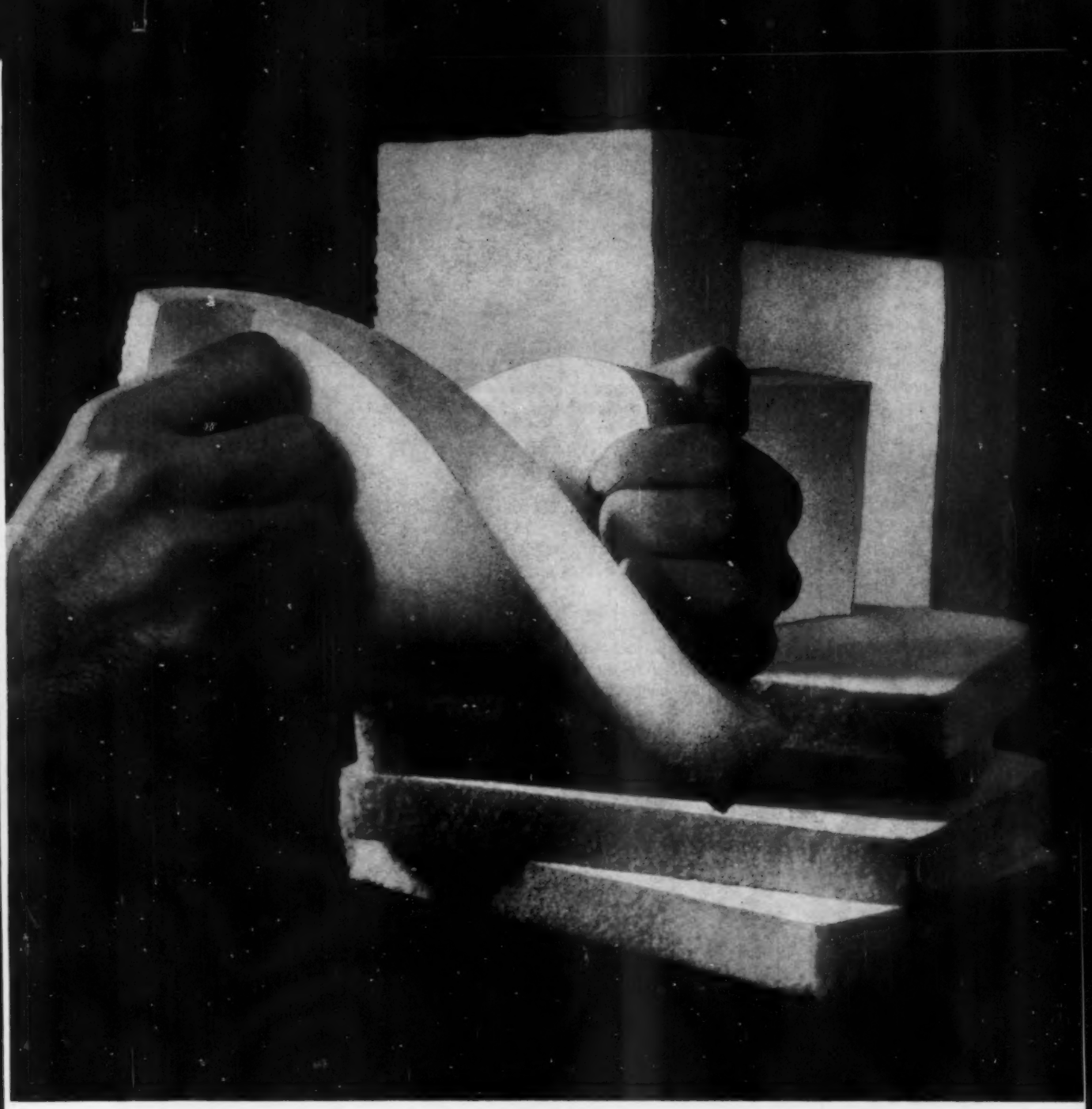

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Furfuryl alcohol

(From pp. 135-140)

obtain brittle, soluble, fusible intermediate resins which cured with hexamethylenetetramine. Laminates, coatings, and molding powders were prepared for these resins.

Addition of furfuryl alcohol to a phenolic resin has been shown to have a pronounced effect on the properties of the end-product. Whereas phenolic resins are readily attacked by alkalies, furfurylated phenolics are inert to them. And the products appear to have the acid resistance of a phenolic resin.

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The fact that furfuryl alcohol is truly a reactive solvent for systems of this type is evidenced in two ways. First, when castings containing as much as 20% furfuryl alcohol were cured at 300° F. for 17 hr. and then at 425° F. for 17 hr., the total weight loss for the cycle was only 0.5 percent. Second, increase in furfuryl alcohol content increased the flexural strength of the final product (Fig. 8, p. 140). This is based on a limited number of castings although tests were run in quintuplicate. Castings were cured to equivalent hardness (Shore D 88) at 105 to 110° C.

Addition of furfuryl alcohol has little or no effect on the electrical properties of the cured resins (Table II, p. 135).

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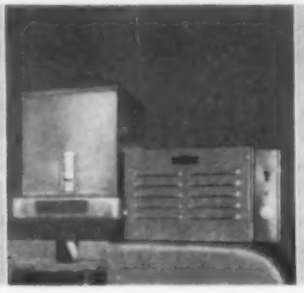

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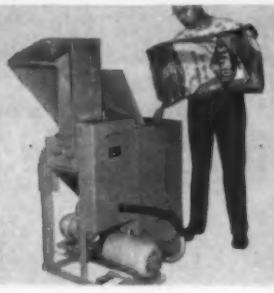

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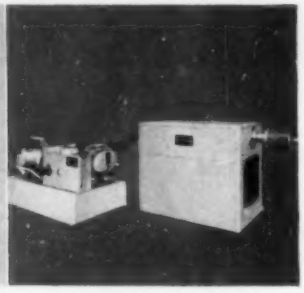

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THE PLASTISCOPE*

Important news . . . and what it means

By R. L. Van Boskirk

Section 2 (*Section 1 starts on p. 39*)

December 1961

Photopolymer plate costs reduced

A price reduction and full-scale production combined with a new manufacturing process have been announced by Du Pont's Photo Products Dept. for its Dycril photopolymer printing plate material. (For details on the photopolymer and how it is processed into plates, see MPI, Aug. 1961, p. 86.) The undisclosed process by which the material is now manufactured is said to improve the composition of the photopolymer, producing plates of greater sensitivity and cutting down required exposure time from the previous average 7 to about 2½ minutes.

The process has made it possible to reduce blank plate prices by 17% on the average. For example, price of the most widely used blank plate (Type 152 flat) has gone down by 18%, from $9.75 to $8/sq. ft., while the price of another (Type 30 thin flexible) has been reduced by 31%, from $8.75 to $6 per sq. foot. The plates, previously produced on a pilot-plant basis, are now being made at a full-scale commercial plant at Parlin, N. J. Six different types of plates are available, including a new thin plate (Type 25), designed for use as a wrap-around plate in rotary direct letterpress printing or for dry offset printing. Du Pont reports that about 90 printing trade shops and internal users have now installed equipment to process the Dycril plates.

Thermoset molding compound

Availability of a new glass-reinforced polyester molding compound, developed for parts that must combine superior electrical insulating properties with good chemical resistance, has been announced by The Glastic Corp., Cleveland, Ohio. Designed for use in electrical apparatus operating continuously at 130° C., components molded from Glastic Grade 1703-A Compound are said to have excellent dielectric strength (more than 400 v./mil in test specimens), good thermal stability, high corona starting voltages, and good resistance to alkalies, solvents, oxidation, and reduction.

PE resin for garment bags

A new polyethylene resin for extrusion of thin-gage blown film, designated Petrothene 263-66, has been announced by U. S. Industrial Chemicals Co. Film made from the new resin is expected to find widespread use in thin (less than 1 mil), clear, tough protective bags for new and dry-cleaned clothes. According to U.S.I., extensive field tests of film made from the new resin indicate that its tailored slip and anti-block formulation results in easy opening on garment-bag dispensers and soft-goods packaging machinery. In addition, the film is highly receptive to printing inks after electronic treatment. The medium-density (0.923) resin has also reportedly exhibited good processing characteristics at high extrusion speeds, with 0.38-mil film extruded in excess of 200 ft./min. with no breaks.

"Tailored" PS foams

New or modified designations have been given to its major foam insulation products by The Dow Chemical Co. to reflect a trend to tailoring of plastic foams for specialized needs. The product improvements and new designations are: a flame-retardant urethane foam insulation board, still under development, trademarked Thurane FR; a flame-retardant PS foam insulation board with improved thermal insulation value, trademarked Styrofoam FR; a flame-retardant PS foam core board, 24 in. wide and 8 ft. long, for use as insulating core in panel construction, trademarked Styrofoam CB; a flame-retardant perimeter insulation board with improved insulation value, trademarked Scorbord FR; and a flame-retardant foam board wrapped in kraft paper designed largely for roof insulation, trademarked Roofmate SP.

According to a company spokesman, Dow will discontinue all but blue flame-retardant types of Styrofoam for building insulation use.

New propionate formula

A combination of outstanding flow characteristics, good permanence properties, and surface hardness is claimed for Tenite Propionate 325, a new formula introduced by Eastman Chemical Products Inc. Articles molded of this formula are said to have serviceability over a wide temperature range, good impact strength, and resistance to continuous outdoor exposure of 1 year or more. It is said to be the easiest of all Tenite propionate formulas to injection mold, and is also suitable for processing by extrusion, blow molding, and by thermoforming of extruded sheet.

Typical uses include: auto steering wheels, knobs, brush **(To page 210)**

*Reg. U.S. Pat. Off.

S.P.E. elects new officers

The Society of Plastic Engineers Inc., Stamford, Conn., has elected James R. Lampman as president for 1962. Mr. Lampman is Mgr., Organic Chemicals Engineering Materials & Process Lab., General Electric Co., Syracuse, N. Y. Other officers elected for 1962 by the Society's Council are: V.-P., Engineering—John M. Berutich, Sales Eng., Haveg Industries Inc., Louisville, Ky.; V.-P., Administration—Richard B. Bishop, Consultant and Research Associate, Holy Cross College, Worcester, Mass.: Secretary—George P. Kovach, Mgr., Product Development, Foster Grant Co. Inc., Leominster, Mass.; and Treasurer—Samuel H. Greenwood Jr., Sales Mgr., Press Div., F. J. Stokes Corp., Philadelphia, Pa. They will take office on Jan. 31, 1962, following their inauguration at the Society's Annual Technical Conference in Pittsburgh, Pa.

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Berutich

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Greenwood

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THE DOW CHEMICAL COMPANY DOW Midland, Michigan

THE PLASTISCOPE

(*From page 208*)

handles, pen and pencil sets, and containers of various types. The new propionate is available in a crystal transparent as well as in other transparents, and in translucent, opaque, pearlescent, and variegated colors.

PP plant "on stream"

Representatives of Montecatini Soc. Gen. and its American manufacturing subsidiary, Novamont Corp., have announced that the company's isotactic polypropylene (PP) operation at Neal, W. Va., is officially "on stream." According to Lucio Lucini, president of Novamont, the plant can produce 30 million lb. of PP annually, and distillation columns and general utilities already built are sufficient to enable the company to double output of PP resin.

Mr. Lucini also reported that a plant for the production of Montecatini's Moplefane PP film would be built in 1962 by Novamont at the Neal site. Capacity is expected to be more than 1 million lb. per month.

Anti-static agent for PVC

Two new anti-static agents for use in PVC formulations that are claimed to have no significant effect on heat stability have been announced by Advance Solvents and Chemical, New Brunswick, N. J. Called Advastat 50 and 51, either of these two liquid products—when incorporated into PVC plastisol or flexible calendered, molded or extruded products at levels up to 5 p.h.r.—are said to be effective in reducing static electrical charges.

According to the company, both products consist of 100% active material and should be considered partial replacements for equivalent amounts of primary or secondary plasticizer. In plastisols, both products are said to function as viscosity-control and air-release additives in addition to being anti-static agents. In calendering and extrusion formulas, they function as lubricants.

RP meat containers approved

Approval of certain of its Toteline products for use with meat and meat foods has been given to Molded Fiber Glass Tray Co., Linesville, Pa., by the Meat Inspection Div., U. S. Dept. of Agriculture. The RP trays and boxes, used primarily for bulk handling of meat, were found suitable from toxicity and extractability standpoints for contact with food. Approval covers unpigmented RP containers and also those of specified brown, pebble, white, and gray pigmentation. Polyester resins used in the trays and boxes have previously received approval from U.S.D.A.

Extruder manufacturer marks half-century

Reifenhauser KG Maschinenfabrik, Troisdorf, W. Germany, one of the world's leading manufacturers of extrusion machines and related equipment, marked its 50th anniversary on Oct. 21. Hans Reifenhauser, managing director and a son of the founder, Anton Reifenhauser, is shown below addressing a group of the company's 728 employees during ceremonies held

at the plant in Sieglar. Founded in Troisdorf in 1911, the firm started out as a carriage blacksmith shop, later branching out into machinery manufacturing, and eventually coming out in 1948 with an extrusion machine. The company has exclusive representatives in 47 countries, licensees in several other countries, and a subsidiary, Reifenhauser Ltd., in England. Some 60% of the company's extruder production goes into the export market.

Flame-retardant decorative laminates

Formica Corp. has announced a flame-retardant decorative laminate, designated FireBrake. The new laminate's flame-spread resistance has been tested and certified by UL and also meets NEMA specifications, including dimensional stability, for a general-purpose decorative laminate, the company states.

New vinyl compound

A semi-rigid vinyl compound with electrical conductive and anti-static properties has been announced by Apex Tire & Rubber Co., Pawtucket, R. I. Designated Apex 750, the compound may be extruded, molded, or calendered. Suggested uses are as a replacement for copper braid in communication wire, as shielding wire for high-voltage and coaxial cables, and as conductors for motor ignition wire.

Vinyl monomer price raised

A half-cent increase in the price of its vinyl chloride monomer has been announced by the Dow Chemical Co. The boost, which brings the price to 8¢/lb., went into effect on Nov. 1 and applies to both contract and spot order sales. According to Dow spokesmen, the increase was based on the view that the previous monomer price was unreasonable from the standpoint of profitable operation.

Graduate plastics course

A program of graduate studies in plastics engineering and fundamental research in plastics, and the availability of fellowships and research assistantships in the program, have been announced by Prof. Louis F. Rahm, Dir., Plastics Laboratory, Princeton University. The course, leading to either a master or a doctoral degree in engineering, is particularly directed to chemical, electrical, and mechanical engineers, and to chemists and physicists.

Fellowships with stipends of from $1500 to $2100, plus tuition and fees, are available. For students not on fellowships, the program offers employment opportunities as half-time research assistants at $2450 per academic year. Applicants for admission must hold a bachelor degree in engineering or physical science from a recognized institution, and must meet general admission requirements of Princeton's Graduate School.

PE extrusion coating resins

Seven polyethylene resins for extrusion coating and laminating of paper, paperboard, foil, films, and fabrics are announced by Dow Chemical Co. The new resins were primarily developed for the packaging industry, with potential applications ranging from multi-wall bags and boil-in-bag pouches to milk carton stock and overwraps. The resins include: CG (for "Coating Grade") 1902, 1705, 1705-B, 1608, 2502, 2504, and 3002. The first two numbers indicate density, with the addition of 0.9 (*e.g.*, 0.930 density for CG 3002), and the last digit approximates melt index. The "B" suffix refers to black pigmentation.

Vinyl plastisol price hike

Increased expenditures for research and development were cited as the reason behind a 1¢/lb. increase in the price of its vinyl plastisol resins by Naugatuck Chemical Div., U. S. Rub-

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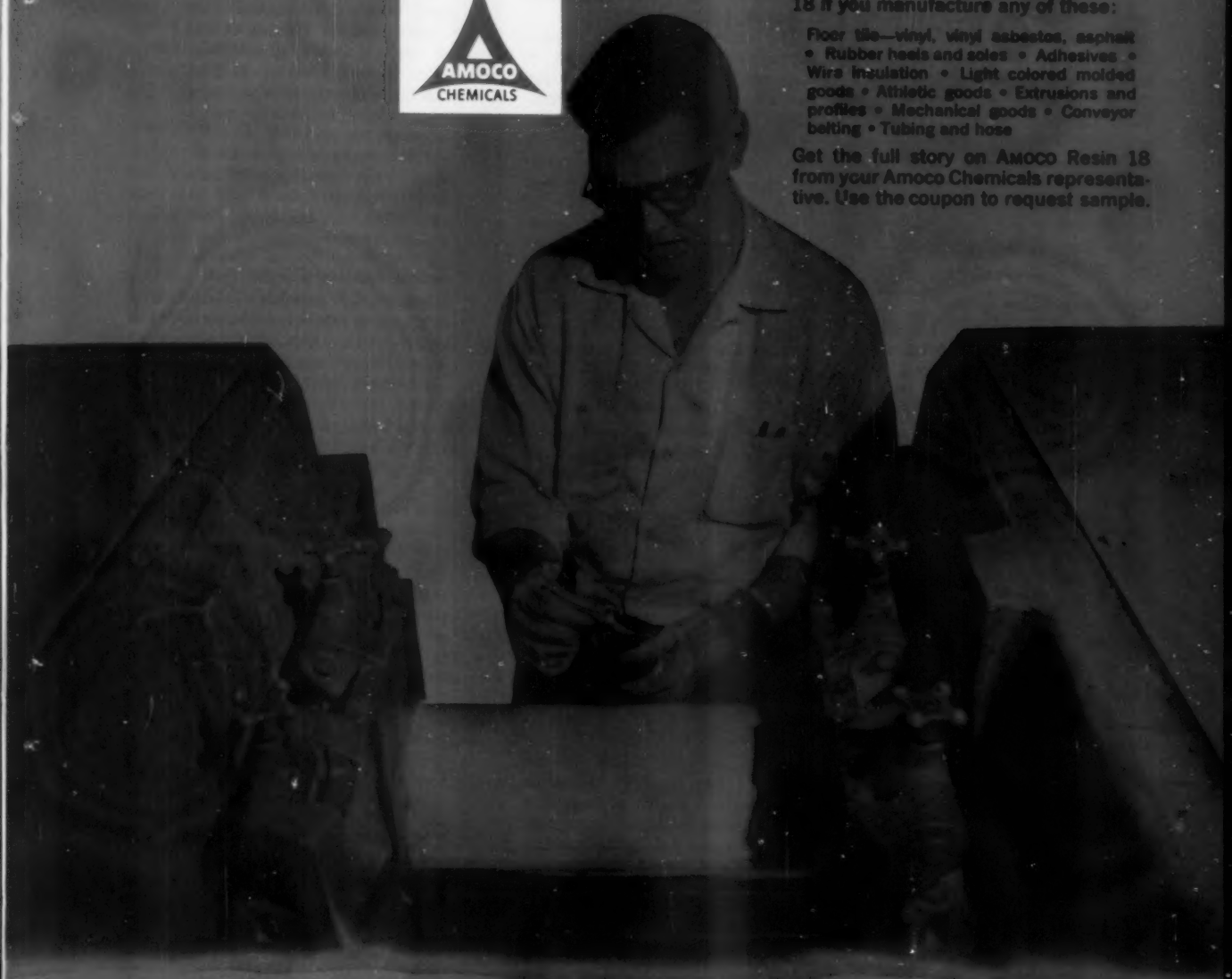

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THE PLASTISCOPE

(*From page 210*)

ber Co. The new price is 25¢/lb., effective Nov. 1. The increase is the first in Naugatuck's vinyl products line since 1951.

Postformable tubing

Two new grades of postformable laminate tubing are now available from Westinghouse Electric Corp., Micarta Div., Hampton, S. C. Both are said to have sufficient thermoplasticity to allow the tubes to soften when heated for 5 min. at 135 to 150° C., after which they can be given a permanent configuration. Properties reported for the tubing are: Compressive strength — 18,500 p.s.i. for the paper-based grade (HP-370) and 23,300 p.s.i. for the cloth-based grade (HY-371); water absorption—2.1 and 0.8%, respectively. Internal diameters range from ⅛ through 1 in., wall thicknesses range from 1/32 through 3/16 in., and maximum length is 46 inches.

Urethane foam group

A Urethane Commercial Group, representing flexible and rigid foam producers, raw material suppliers, and machinery manufacturers has been established within the Cellular Plastics Div. of the Society of the Plastics Industry Inc.

Chairman of the Group is John Hull, manager of urethane chemical sales, Allied Chemical's National Aniline Division. The Foam Producers Committee is headed by John Gulick, sales manager, Nopco Chemical Co., and the Raw Materials Suppliers Committee is under the chairmanship of William A. McGregor, who is manager of foam chemicals sales, Mobay Chemical Co.

The Urethane Commercial Group has been organized to broaden existing foam markets, to develop new markets, and to establish quality standards and specifications for flexible foam applications.

New epoxy resins

Commercial production of a new series of polyepoxide resins, designated KER resins, was announced by Koppers Co. Inc. at the dedication of the company's new Research Center at Monroeville, Pa.

A major difference between KER resins and diepoxides is the availability of more than two reactive epoxy groups. The advantage of this higher functionality of polyepoxides is that it permits resin formulators to vary the properties of end products to a greater degree than was previously possible. Unlike conventional epoxy resins derived largely from bisphenol A, KER resins are derived from an ortho-cresol-formaldehyde novolak which is then reacted with epichlorohydrin to form a polyepoxide. The molecular weight of the novolak determines the molecular weight of the KER resin, the functionality of which may range from 2.5 to 5.5.

The different properties of Koppers polyepoxides can be explained by their molecular structure, which permits a high degree of chemical cross-linking in cured resinous products. This highly cross-linked structure results in improved thermal properties as well as high resistance to solvents and chemicals.

The numerous reactive epoxy groups in the new series are also said to provide a greater opportunity for modifying resin properties, such as by esterification with fatty acids. In addition, KER resins cure in less time to stable, inert products, the company states.

High-heat-resistant epoxy

Commercial quantities of a new high-heat-resistant epoxy resin are available from Thermoset Plastics Inc., Indianapolis, Ind. ASTM tests are said to indicate a heat-distortion temperature in excess of 572° F. The product, Thermoset 607, is available as a pure resin or in laminating or casting resin versions. Usages foreseen include adhesives, coatings, electrical insulating, and plastic tooling. Specific uses include electrical encapsulating and potting compounds and prototype molds for plastic and rubber parts.

Extruded Teflon sheets

Sheets of extruded Teflon are now available from Tri-Point Industries Inc., Albertson, N. Y., in lengths up to 10 ft. in sizes from ¼- to 1-in. thick by 6-in. wide. The material may also be obtained in continuous lengths. Widths up to 24 in. will be available in the near future, the company states.

Mylar-vinyl lamination

Voss Belting and Specialty Co., Chicago, Ill. has been selected by Riegel Paper Corp. as exclusive manufacturing fabricator for Permagloss and Permatrak laminated plastic conveyor belting for the food, tobacco, and cosmetics fields. Permagloss and Permatrak belting materials are made of a lamination of Mylar polyester film and vinyl which, according to Riegel, results in long-life, high-strength belting that is smooth, stable, and resistant to most acids and alkalies. Permatrak is made with a special series of lands and valleys in the vinyl side parallel to the belt edge to give better tracking control. Riegel will continue to laminate the basic material.

Teflon monofilaments

Monofilaments made of Teflon FEP fluorocarbon resin are under study by a filaments marketing section of Du Pont's Polychemicals Dept. for possible use in brush applications where problems result from contact with acids and chemicals. Because of the stable, anti-frictional characteristics of Teflon, monofilaments of the FEP fluorocarbon may provide a premium bristling material for brushes which face exposure to corrosive elements, extreme temperatures and sticky ingredients. FEP monofilaments are available in diameters of 5 and 11 mils, but other sizes can be supplied for developmental purposes.

Extrusion coating for fabrics

A technique for producing vinyl-coated fabrics at lower costs has been developed by Haartz Auto Fabrics Co., Boston, Mass., based on a process development of Union Carbide Plastics Co.

The new technique, extrusion coating with vinyl chloride, offers advantages over knife and roller coating methods because extrusion-coated plastisols are pre-fused; thus, no subsequent heating steps are required, the company claims. Extrusion coating allows use of higher-molecular-weight resins, produces little or no shrinkage, and provides only moderate penetration of the fabric. A variety of substrates can be coated including knitted materials and synthetics, it is said.

Extrusion-coated fabrics produced by Haartz are presently finding markets as replacements for convertible auto tops, auto upholstery, door liners, head liners, and as boat covers and upholstery for chairs.

High-temperature phenolic prepreg

Reinforced plastic fabricators can save 100% of post-cure time by using Pyropreg AC Type II to meet military requirements for short-time exposure at 500° F. or higher, according to Cordo Molding Products Inc., Norwalk, Conn. Pyropreg AC Type II does not require a post cure to meet the half-hour exposure requirements. Mechanical property data has been reported up to 800° F. Pyropreg is claimed to contain chemi-

cals which allow less decomposition of the resin at higher mean temperatures than are encountered in normal phenolic resins.

Transparent epoxy potting compounds

A new series of epoxy potting and encapsulating compounds, available in a variety of transparent colors to allow both color coding and viewing of embedded components regardless of casting size, has been introduced by Techform Laboratories Inc., Venice, Calif. Designated Series EPC 100, the compounds, available with a curing system tailor-made to suit any application, are said to cure with low shrinkage and to yield products of superior physical and electrical properties that will withstand both thermal cycling (as per MIL-T-27A) and high heat-distortion temperatures.

Molecular alloys

A new modular method of producing hexamethylene diamine, adipic acid, and caprolactam, said to permit greater flexibility in the manufacture of Type 6/6 and Type 6 nylon has been announced by Belding Heminway Co. Inc., New York, N. Y. The products, trademarked Moleculoys, will be manufactured and sold by Belding Corticelli Industries Inc., the chemical and plastics subsidiary of the company. The raw materials produced by the company's new process can also be used, with the further addition of spinning equipment, to produce nylon yarn in filament form.

Coloring for polystyrene foam

Development of three new products for coating and coloring polystyrene foam for display, novelty, and toy items has been announced by Adhesive Products Corp., New York, N. Y.

Polylume, a flame-resistant, high-gloss aluminum coating, produces a decorative metallic finish closely resembling foil. It can be applied by dip, brush, roller, or spray.

Fluriglo makes it possible to coat polystyrene foam with a brilliant range of luminescent and conventional colors, and is said to also strengthen the surface of the foam.

Flok-Grip, a non-inflammable adhesive, makes it possible to flock glitter and other materials on polystyrene foam and other surfaces.

Wire and cable resin coats 4000 ft./min.

Development of a polyethylene resin which can be extruded to give telephone and control cables smooth insulation coatings at speeds as high as 4000 ft./min. has been announced by the Polyolefins Div., Polychemicals Dept. of Du Pont. It is known as Ala-

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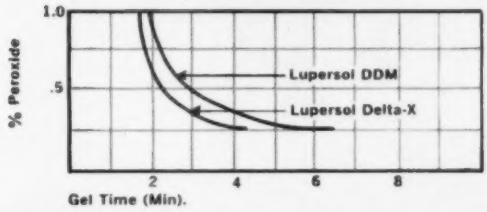

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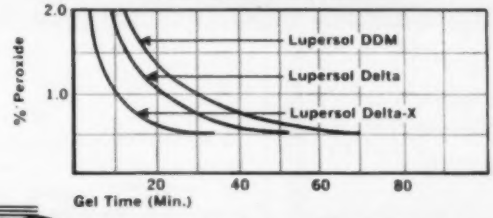

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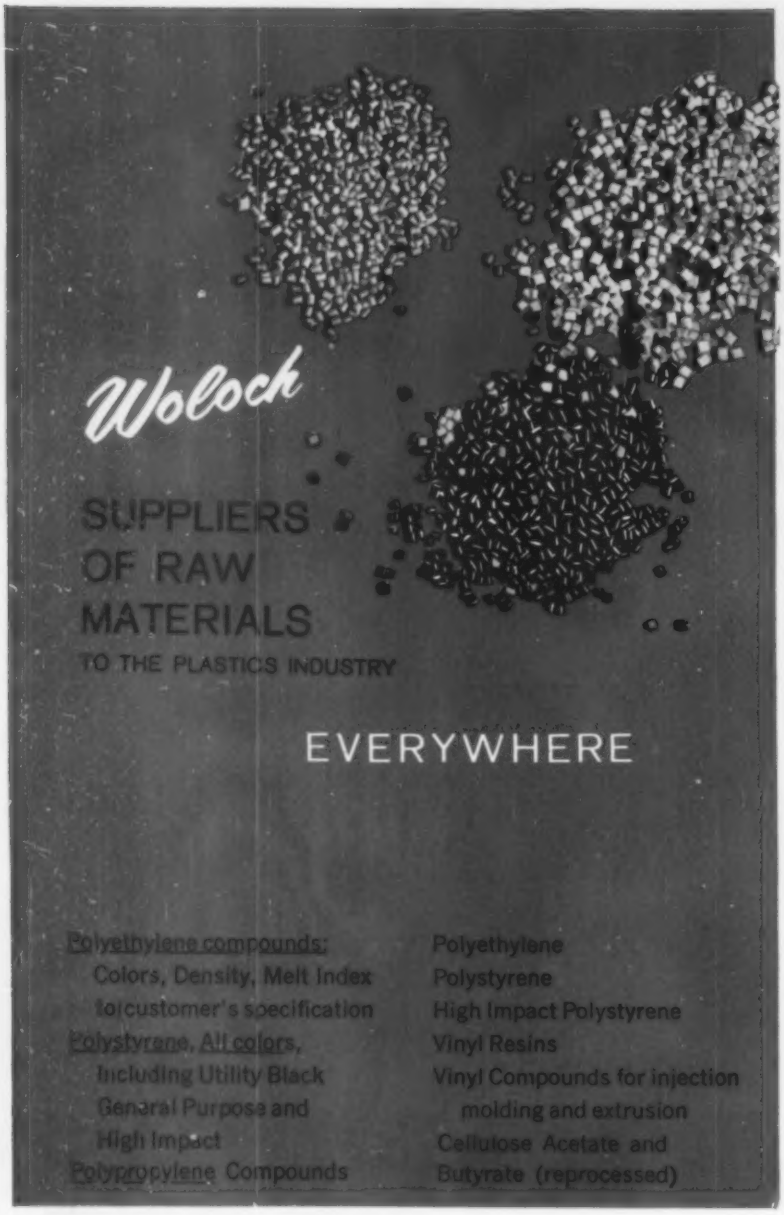

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(*From page 213*)

thon 3530 PE resin. Du Pont states that measurements on 10-mil coatings over No. 22 AWG, applied at 3800 ft./min., deviate only 13 microinches from a normal diameter. Since the molecular weight of the new polyethylene resin is higher than general-purpose insulating polyethylenes, its melt index of 0.3 is lower. Stock temperatures in the range of 400 to 450° F. have provided good coatings. Ten standard Munsell colors, based on this resin and coded Alathon 3533, are also available.

Shrink-proof liquid casting compound

Development of a new, shrink-proof liquid casting compound, which can be cast to almost any thickness or size and which is said to be suitable for both solid casting and hollow slush molding has been announced by Allen Plastics Corp., New York, N. Y. The new compound, designated Alplex, can be cast in rubber, plaster, or wood molds and, according to the company, yields strong, perfectly detailed castings which are waterproof and resistant to heat, solvents, and weather.

Alplex is a 100% solids compound which requires no heating or cooling. Cast objects can be removed from molds within 10 to 20 minutes. It is recommended for making museum reproductions, models, displays, garden ornaments, lamp bases, and for tooling. It is available in 55-gal. drums and in 1- and 5-gal. containers.

Identifying polymers

Development of a speedy, simple new method of identifying unknown rubber and textile polymers has been reported by a Goodyear Tire & Rubber Co. scientist. J. Kyle Phillips, of the firm's research headquarters at Akron, Ohio, said elastomers can be identified within a few minutes by combining mass spectrometry and high-temperature pyrolysis. The new analytical procedure to date has been used primarily to identify rubber and textile polymers, but preliminary tests show it also can identify acetates, chlorides, ethers, and many other polymer types.

Another PE line wire covering

A low-density polyethylene extrusion compound for use on line wire and service drop cable, claimed to have exceptionally high stress-cracking resistance, is now available from Union Carbide Plastics Co. Designated Bakelite DFD-0745 Blk 9845, the com-

IF YOU SPEND OVER

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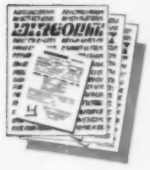

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pound (density, 0.93; melt index, 0.3) is stabilized for weatherability by the addition of carbon black. Compound temperature at the die is 400° F. According to the company, handling is easier, reels hold a greater footage of wire, and span load between poles is decreased as a result of the thinner, smoother coatings that can be applied with the new compound.

Epoxy anchors bolts

Few people today are aware of the vast possibilities for epoxy adhesives. The next generation will probably be using them as often as, maybe more often than, nails, bolts, cements, etc. The latest is Shell Chemical Co.'s new high-strength adhesive, Epon 907, that can be used for embedding bolts, pipe screws, studs, rivets, and other metal fasteners into concrete and similar construction materials. The adhesive is said to bond all types of metal rods and tubing without need for lead anchors, plugs, expanders, or other conventional holding devices.

It is an economical, general-purpose maintenance adhesive many times stronger than concrete, the company claims. Within 24 hr. the adhesive develops the peak tensile shear strength of 3000 p.s.i., and is, therefore, suitable for holding down machinery and other equipment. The adhesive won't sag or run and can be used to bond bolts in walls and ceilings, as well as in floors. According to the manufacturer, tests show that the adhesive remains structurally useful after 18 months' outdoor exposure, 6 months' soaking in water or gasoline, or exposure to temperatures between —67 and 150° F.

For in-plant and field service, Epon 907 is recommended for general repair bonding of metals, masonry, marble, ceramics, and other construction materials. The two-component system is available in tubes and standard package sizes, and can be stored safely for at least 1 year before mixing, the company states.

Expansion

Allied Chemical's Barrett Div. has announced plans for the construction of facilities to produce corrugated rigid PVC building panels. The new plant is scheduled for completion in early 1962. The material is currently produced in pilot quantities from unplasticized resin supplied by a number of raw material producers. It is extruded as flat sheet and then post-corrugated. Thickness is 0.047 in. and standard lengths of 12, 16, and 20 ft. are available, all in widths of 43 inches. The company states that continuous lengths, for wrap-around applications, can be produced. Weight of the panel is ½

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DIELECTRIC PREHEATERS FOR

- PREHEATING MOLDING MATERIALS
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- AUTOMATIC MOLDING
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Made possible, made better, made for less

made with CHEM-O-SOL®

SCREENS and SPRINGS and "SPAGHETTI"

Chem-o-sol, the most adaptable plastic for coating, molding and gasketing, makes screening strong, long lasting, weather-resistant — and *practicable*. Colorful, too. Chem-o-sol is die-wiped on glass yarn or aluminum wire, at 600 feet per minute.

Auto seat springs shouldn't be seen — or *heard*. Chem-o-sol (flow-coated on springs at troublesome rub-spots) takes the squeak out. Here's how: special formulation for maximum flexibility, abrasion-resistance. Fast, easy, economical application.

Some electrical applications call for spaghetti tubing with extra resistance to abrasion, "cold flow" and heat. Reinforcement is vital; Chem-o-sol's liquidity makes it possible. Result: glass and vinyl can work together in a sleeving to beat problems neither could lick alone. Even defy heat up to 225°F.

and YOUR PRODUCT or IDEA-FOR-A-NEW-PRODUCT

CHEMICAL PRODUCTS CORPORATION East Providence, Rhode Island

HOW CHEM-O-SOL MAY HELP YOUR PRODUCT OR PRODUCT-IDEA

Tailor-made for you! We have a world of experience in specialized formulation, plus the industry's most complete laboratory.

Color? You name it! Chem-o-sol has done wonderful things with color. If color is one of your problems, just ask us to *prove* that we can reproduce your most difficult shades and tones — precisely, in quantity production, without annoying variation.

Processing? Just heat it! Dipping, molding, casting, spreader-coating, foaming, wiping, spraying, printing, pressure-forming . . . Chem-o-sol is the all-process plastic. Formulated as a liquid without volatile components, it changes to a strong, resilient solid — simply by heating to about 350°F., without pressure.

Versatile! More than a coating, molding or gasketing compound, Chem-o-sol is a new basic material that has widened the useful horizon for vinyls. From coatings for cosmetic containers to joints for sewer pipe, Chem-o-sol is the practical, practicable answer. Can it help *you* — cut production time and cost, make a *better* product, create a *new* product?

Adaptable! Just for example . . . *Tensile strength:* up to 2700 psi. *Elongation:* 150% to 600%. *Hardness:* Shore A2 as required from 10 to 100, Shore D up to 65. *Flexibility:* to withstand temperatures as low as minus 65°F. *Chemical resistance:* impervious to most acids, alkalies, detergents, oils, and some solvents. *Heat resistance:* to 225°F. for as long as 2,000 hrs.; to 450° for two hours and more. *Dielectric strength:* minimum 400 volts per mil when fused in sections 3 mils thick. *Solids content:* 100%. Can be molded in very thick sections. *Viscosity:* meets all requirements for widest range of application-processes.

FREE HELP

Yours for the asking: Fact-filled Chem-o-sol brochure. Send to:

CHEMICAL PRODUCTS CORPORATION
Dept. P12, King Philip Road
East Providence, R. I.

Name.....

Title.....

Company.....

City..... Zone..... State.....

THE PLASTISCOPE

(*From page 215*)

lb./sq. yd. Pitch of the corrugations is 2.76 in., depth is 0.71 inch. Colors available are green-white and gray opaque, and green, neutral, and yellow translucent. Developmental price is 35¢/sq. ft.

FMC Corp. plans to build a new multi-million-dollar facility to produce toluene diisocyanate on the site of the former Naval Ordnance plant in Charleston, W. Va. This property, purchased from the Federal Government, adjoins the company's chlorine-caustic plant, which will provide a substantial portion of the raw materials needed for producing the new chemical. Plans call for construction to start early next spring, with initial operation scheduled for late 1963. This represents FMC's first step into the isocyanate industry.

Holophane Co. is constructing a 60,000-sq.-ft. plant in Edison, N. J., to produce acrylic prismatic lenses. Completion is scheduled for spring, 1962.

National Starch and Chemical Corp. has selected Seadrift, Texas, as the site on which to build a previously announced $4 million vinyl acetate plant. The annual capacity of the new chemical facility reportedly will be 45 million lb., most of which will be for captive use. The new plant is expected to be in operation late in 1962.

National also has under construction at Meredosia, Ill., a commercial-scale facility for producing its Resyn 28-1310, a polyvinyl acetate copolymer introduced two years ago, and currently produced on a semi-commercial basis at the company's Plainfield, N. J. plant. This facility is scheduled to be in full operation by Jan. 1, 1962.

Monsanto Chemical Co. has dedicated its $10 million research center in Creve Coeur, a suburb of St. Louis, Mo. The center, which includes six new buildings covering almost 11 acres, provides research laboratories for six Monsanto operating divisions, and represents about one-third of Monsanto's total research effort. The center will ultimately provide facilities for 800 scientific and supporting personnel. By the end of this year, about 370 persons will be working in the new buildings.

Part of the research activities will be devoted to plastics. However, the center will not replace the Springfield, Mass., plastics laboratories. Instead, the two facilities will supplement each other's activities, with the St. Louis group placing major emphasis on basic exploratory research. Among the research projects currently being pursued are the use of organopolyphosphorus esters for flame retardants, graft polymerization, structoset resins (thermosets processable on thermoplastic machinery), inorganic polymers, and nuclear radiation-resistant resins.

The new center, as well as the other Monsanto research activities, is under the direction of **Dr. Carroll A. Hochwalt,** v.-p. for research, development, and engineering.

Allied Chemical Canada Ltd. has announced plans to construct a multi-million-dollar plant in Ontario for the manufacture of diisocyanates. According to the company, this will be the first plant in Canada to manufacture this product, an important component in urethane foams, and will be scheduled for completion late in 1962.

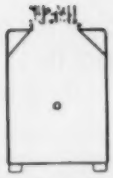
Samuel Moore & Co., Mantua, Ohio manufacturer of extruded plastic products, is expanding its plant for the seventh time since 1947. The current project will bring plant floor space from the present 50,000 to 80,000 sq. ft., and, including new equipment to be installed, represents an investment of about $250,000. Completion is slated for January 1962.

Roto American Corp. has acquired, as a subsidiary, **Miller & Van Winkle Co.,** Paterson, N. J. manufacturer of automatic and semi-automatic molding machinery and auxiliary equipment. **Conapac Corp.,** New York, N. Y., also a Roto American subsidiary, is handling the sales.

Bemis Bro. Bag Co. has entered into an agreement with **Plastic Film Co. Inc.,** Plainfield, Conn., to acquire the assets and business of the corporation as of Jan. 2, 1962, according to a joint announcement. Plastic Flm specializes in coating and laminating of a wide variety of materials, including plastics, foil, films, and paper.

Rowland Products Inc., Kensington, Conn., has completed a 14,400-sq.-ft. addition to its main extrusion plant. New equipment, with capacity to produce an additional 2 million lb./yr. of plastic sheeting, has been installed and is in operation. Rowland manufactures butyrate, acrylic, and cellulose acetate sheets and shapes for the sign industry, as well as applications for home lighting.

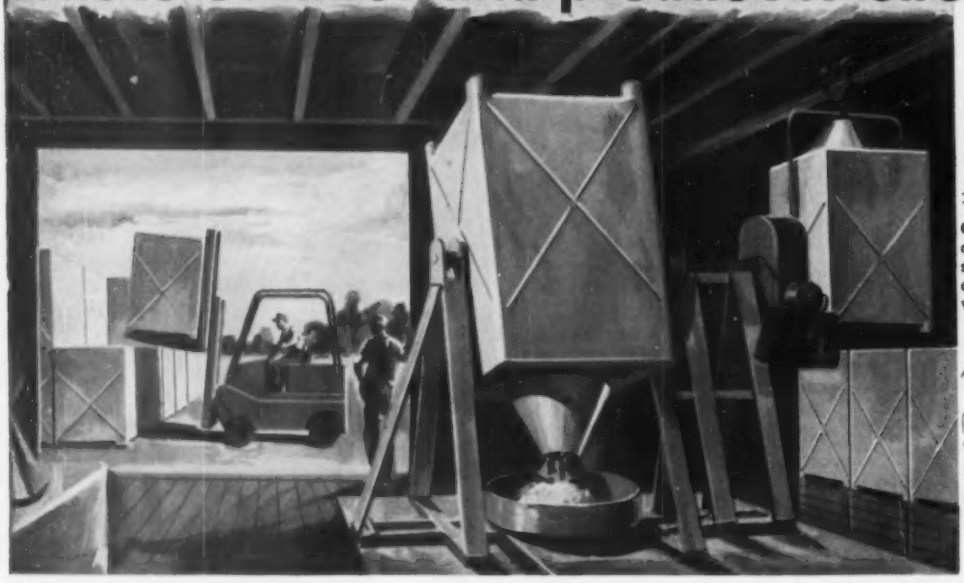
Ductall Corp., Costa Mesa, Calif. manufacturer of flexible plastic hose, has merged into **Hungerford Plastics Corp.,** Morristown, **(To page 222)**



Fills Fast—22" opening permits fast filling of powdered materials. Internal cone conforms to angle of repose of product.

Empties Clean—Internal cone funnels all materials out of bin. No residue remaining.

Waste of labor and product is obsolete...



Cuts Shipping Costs—low cost flat-bed equipment considered part of special rail car with "freight free" advantages.

Stores Outdoors—Weatherproof, turns yard area into warehouse. Stacks 2 high.

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Waste of labor, product, floor space, time is now outmoded—eliminate it in your plant today.

Powell's new Invert-a-bin* Semi-Bulk Handling System has put an end to the biggest headache in handling granular products. These sturdy, easy-to-handle steel or aluminum containers are easy to fill and easy to empty. Weatherproof, they can be stored outdoors freeing indoor storage areas for production.

Ideal for inter-plant or intra-plant these units are considered part of special rail car with "freight free" advantages. Due to the simplicity of design, maintenance of the Invert-a-bin* is nil.

Why continue losing time and money with old style disposable packages when this remarkable new Invert-a-bin* is immediately available on either lease or purchase. Write for literature today!

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MOPLEN polypropylene gives you a combination of outstanding properties at an economical cost: It offers heat resistance to 300°F, inertness to a wide variety of active chemicals, resistance to environmental stress-cracking. ■ What's more, MOPLEN is strong and light in weight—in fact, no plastic is lighter! MOPLEN can be specially formulated to resist sunlight and weathering. ■ Montecatini, the originator of isotactic polymers, has the broadest experience in putting polypropylene to practical use. This know-how is available to you. ■ MOPLEN is being produced in this country by Novamont, Montecatini's U. S. subsidiary. For information and technical assistance get in touch with Montecatini's and Novamont's representative: **Chemore Corporation,** Dept. A, 100 East 42nd Street, New York 17, N. Y., YU 6-7575.

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SJ-Series

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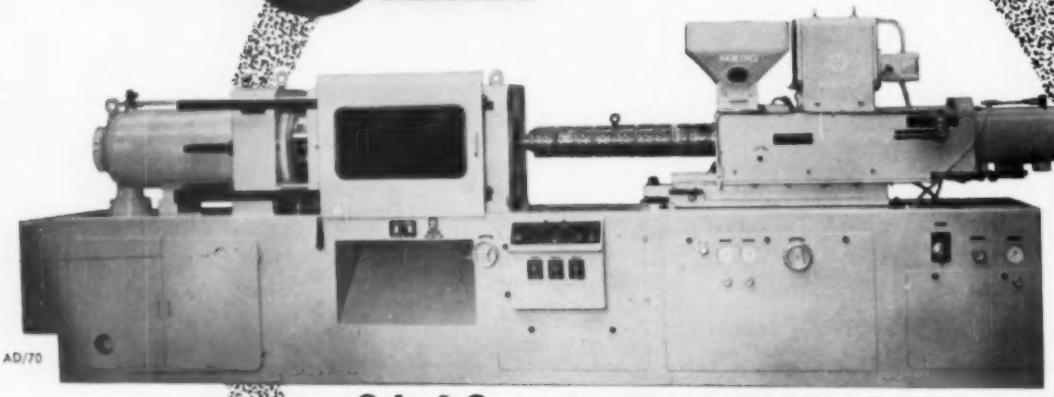
SJ-35

SJ-50

SJ-75



AD/70

SJ-60 INJECTION MACHINE

SJ-90

SJ-120

SJ-150

- Any thermoplastics; unplasticized PVC, ABS, Acetal, Nylon, Polycarbonate etc. can be successfully molded..
- Straight hydraulic clamping of long and adjustable stroke enables deeper or shallower moldings without troublesome link adjustment.
- Adjustable back pressure assures material melting under optimum conditions.
- The Oilgear's hydraulic equipment guarantees dependable operation.

SPECIFICATIONS

NO.		SJ-35	SJ-50	SJ-60	SJ-75	SJ-90	SJ-120	SJ-150
OZ. PER SHOT		6	16	32	72	120	360	1100
CLAMPING FORCE(U.S.t)		84	195	310	480	850	1250	2500
SPACE BETWEEN TIE BARS (in.)	H	10 1/4	14 3/16	18	26 3/16	39 3/8	48 1/2	54
	V	6 5/16	11	16	22 1/4	35 7/16	40 1/2	54

MEIKI CO., LTD.

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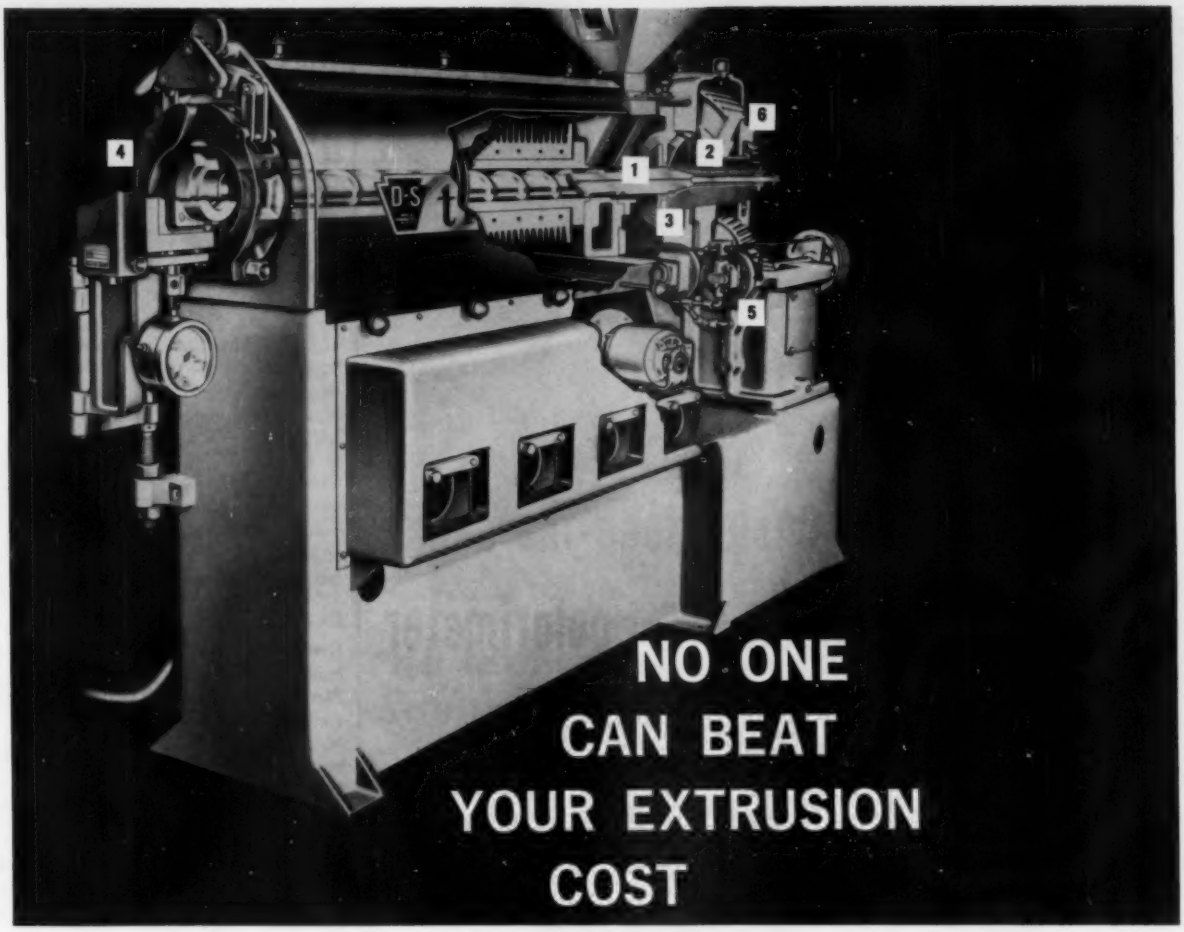

When you're running a Davis-Standard **thermatic** extruder

Advance-design features make the difference

There's no conflict between the twin goals of high quality and high output when you're running a Davis-Standard Thermatic extruder — regardless of your product or process.

Take the problem of temperature control. With Thermatic you have none of the mess, maintenance or worry of liquid systems because Thermatic cooling relies on air — nature's trouble-free medium. Result? Uniform temperatures. Your operators spend their time and energy on **production** — not making temperature adjustments.

Change "Impossible" to "Profitable." You, too, may have recognized the profit potential of the new and improved compounds — only to discover your extruder inadequate. Not so with Davis-Standard Thermatic extruders! They are designed to handle — efficiently — every commercially produced resin available today. What's more, they have the basic strength and simplicity of design to run new resins easily. Every D-S load-carrying component is equal in capacity to that found in the next larger ordinary extruder.

Advance-design features like these provide smooth-running, trouble-free performance:

1. 4-spline screw drive positively eliminates eccentric screw rotation
2. Separate, extra-heavy thrust and radial bearings handle work loads **individually**
3. Labyrinth oil seals eliminate seal replacement
4. Simplified head clamp opens, closes quickly. Positive safety shear pin protects operator and machine
5. Gear-type oil pump has **positive** drive from input shaft — for full lubrication regardless of speed
6. Helical gearing provides more **usable** horsepower. Oversized input shaft and bearings reduce maintenance

Write today for new D-S 8-page bulletin. You'll see why no one can beat your extrusion cost when you're teamed with Davis-Standard.

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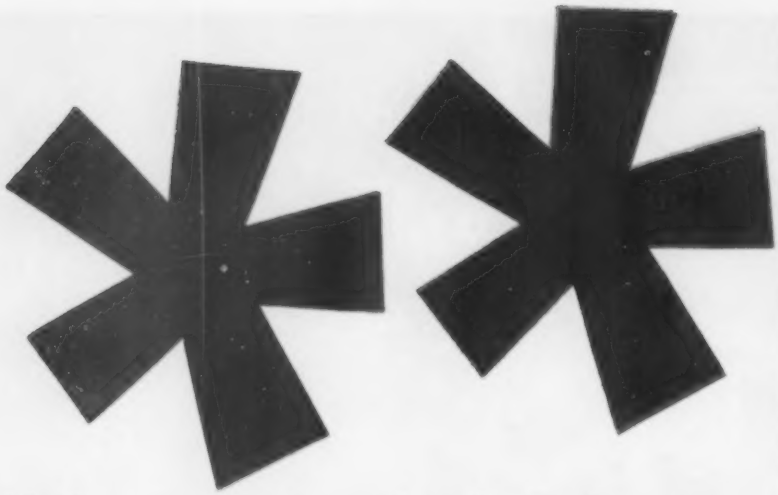
Davis-Standard offers a complete line of Thermatic extruders from 1½ to 8-inches in L/D ratios from 10:1 to 26:1 — and accessory equipment — for blown film, sheet, blow molding, filament, pipe, wire and cable insulating and compounding.



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...for precise color control

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THE PLASTISCOPE

(*From page 217*)

N.J., and will act as a division. **Alfred H. Swan,** president of Ductall, heads the new division and becomes a director of the surviving Hungerford Corp.

A. H. Wirz Inc., Chester, Pa. manufacturer of collapsible tubes, has expanded its blow-molding facilities at Swedesboro, N. J., with the addition of several blow-molding machines and an additional 7000 ft. of warehouse space for storage of undecorated stock bottles. Wirz is equipped to produce a full line of PE bottles ranging from ½ oz. to 1-gal. sizes. **G. R. Redgrave,** who is in charge of the Swedesboro operation, was responsible for the design and development of a great amount of Wirz's automatic high-speed tube equipment.

Deceased

Kenneth B. Cary, 54, chairman of the board and president of **Woodbridge Plastics Inc.** and **The Tyson Corp.,** died Oct. 11 at his home in Montclair, N. J. Mr. Cary joined **Hamilton Laboratories Inc.** in 1945 as vice-president, and in 1949 was appointed vice-president in charge of sales for **The Burgess Chemical Co.** This company was reorganized into **Cary Chemicals Inc.,** with Mr. Cary becoming chairman of the board and president. In 1960, he purchased The Tyson Corp. and formed Woodbridge Plastics.

Coming events

Plastics groups

Jan. 30-Feb. 2, 1962: S.P.E. 18th Antec, "Plastics Revolutionize Design," Penn-Sheraton Hotel, Pittsburgh, Pa.

Feb. 6-8: S.P.I. 17th Reinforced Plastics Div. Conference, Edgewater Beach Hotel, Chicago, Ill.

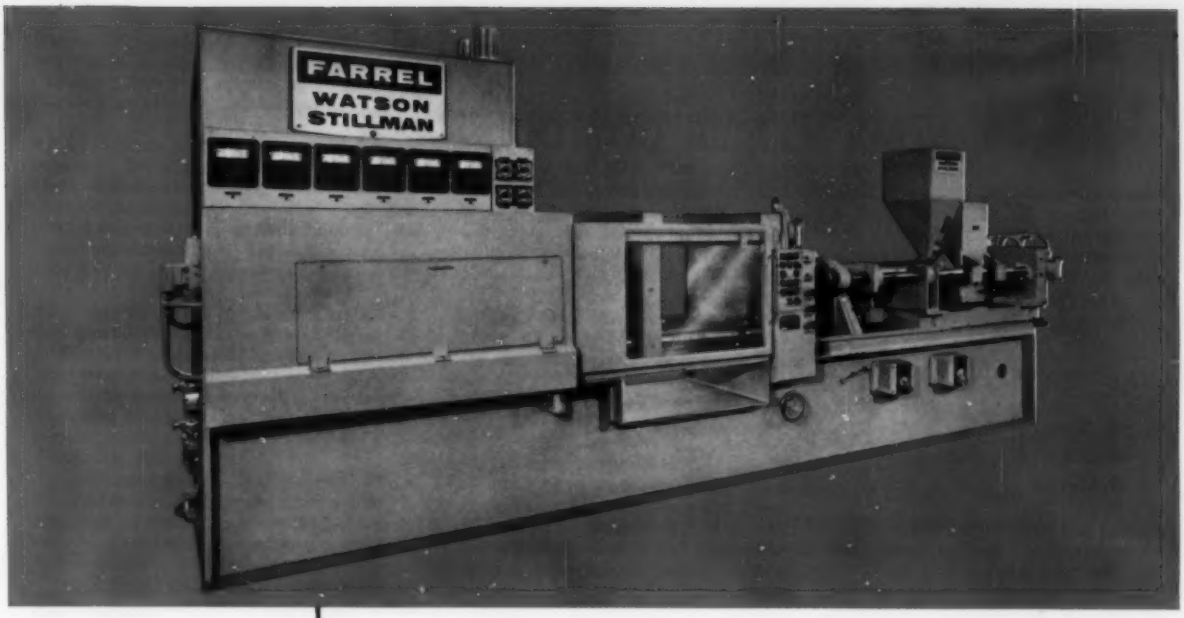
May 18-29: Europlastique 62, Porte de Versailles, Paris, France. Contact: Paul Thevenin, Secretariat d'Europlastique, 10 Rue du Mont Thabor, Paris 1e.

Other groups

Jan. 5: Akron Polymer Lecture Group, "Infra-red Spectroscopic Studies of Polymers," University of Akron, Akron, Ohio.

Jan. 15-19: 36th National Housewares Exhibit, McCormick Place, Chicago, Ill.

Feb. 2, 3: Chemical Market Research Assn. (CMRA) Meeting, Warwick Hotel, Philadelphia, Pa.—**End**



S-20-350

SPECIFICATIONS

Capacity of hopper (pounds)	150
Maximum ounces per shot — (Styrene)	20
Plasticizing capacity of cylinder per hour (Styrene)	210
Shooting capacity (cu. inches per min.)	1290
Clamping capacity (tons)	350
Daylight opening (inches)	32
Minimum die thickness (inches)	8
Maximum die sizes (inches)	20½ x 34½
Floor space required	19'9" x 6'7"

The ideal machine for molding heat-sensitive materials

News for molders interested in an extra degree of product quality is the Farrel Watson-Stillman S-20-350. This version of the company's 12-20 ounce machines features a screw-type plasticizer offering many molding advantages, such as higher-strength parts and superior color dispersion. Furthermore, many of the recently developed plastic materials, particularly the heat-sensitive and more viscous types, can be run with great success on this equipment. They are worked mechanically and as a result are more uniformly heated.

Three standard screws are available for molding all the commonly used plastics . . . while a special screw is supplied for rigid P.V.C. Contributing to the machine's flexibility is a hydraulic motor delivering infinitely variable screw speeds.

The S-20-350 can be obtained with a choice of 41 optional features! These, as well as standard features and complete specifications, are covered in bulletin 601. Write for a copy today.

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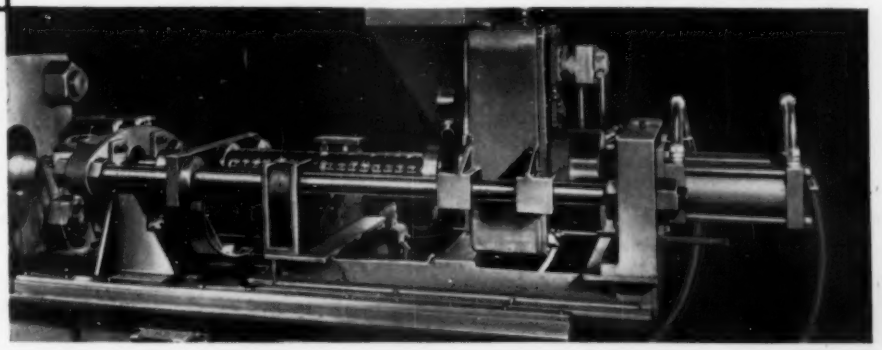

WS-87

COMPANIES...PEOPLE

Firms and personnel in the news—what they're doing . . . and where

Monsanto Chemical Co., St. Louis, Mo.: **Robert K. Mueller** elected a member of the board of directors and a member of the exec. committee. **John R. Eck** elected a v-p and ap-

R. Mueller

J. R. Eck

pointed gen. mgr. of the Plastics Div., succeeding Mr. Mueller, who has held this post since 1952.

In a realignment of two Texas operating units announced by Monsanto, the Chocolate Bayou Project and administration of manufacture of monomers at the Texas City plant were combined into one div., which will be known as the **Hydrocarbons Div. The Lion Oil Co.** also will be a part of this div. Polymers produced at Texas City and marketing of monomers will remain the responsibility of the Plastics Div. **H. Harold Bible,** v-p, and gen. mgr. of the former Lion Oil Co. Div., will serve as gen. mgr. of the Hydrocarbons Div. **F. E. Reese,** asst. gen. mgr., Plastics Div., transfers to the Hydrocarbons Div. as asst. gen. mgr. He will continue to maintain headquarters at Texas City.

Allied Chemical Corp.—Plastics Div.: Frank L. Holloway appointed to newly-created position of mgr. of market development. This new dept. will be concerned with sales development of new applications of the Div.'s thermoplastics. Other members of the dept. include **David W. Towler, John J. Taylor,** and **Eugene B. Hilker.**

National Aniline Div.: Ian C. Twilley promoted to group leader, polymer research, and **Albert H. Wiesner** promoted to group leader, polymer development, in the R & D Dept.

Sun Chemical Corp., New York, N. Y.: **Dr. Eugene Kraiman** and **Daniel J. Carlick** appointed research group mgrs. at the newly established **Corporate Research Center,** located in Carlstadt, N. J.

California Chemical Co.: T. G. Hughes appointed to newly created post of v-p in charge of marketing for all California Chemical operations in the U. S. and abroad. He is succeeded as pres., **Oronite Div.** and pres., **California Chemical International Inc.** by **T. M. Welton. H. B. Pollock,** formerly sales mgr. surface coatings and plastics chemicals, replaces Mr. Welton as Oronite's v-p and mgr. of marketing. **B. W. Colaianni,** Oronite marketing specialist in surface coatings and plastics chemicals, named to new post of product mgr. for these products.

Urethane Corp. of California, mfr. of flexible urethane foams, with plants in Compton and Burlingame, has announced startup of new facilities for production of rigid foams: **William E. Lowery,** formerly with Dow Chemical Co., named mgr., rigid foam products. **Kurt Wertheimer** joined the company as product mgr. of the newly formed Consumer Products Div. **Robert R. Tetrick,** formerly asst. sales mgr., and **George Rothage,** key acct. salesman, promoted to product mgrs., Flexible Foams Div.

Du Pont Co.—Polychemicals Dept.: Herbert S. Lecky appointed director, Polyolefins Div., replacing **Roy L. Schuyler,** who became asst. gen. mgr. of the dept. In his new post, Mr. Lecky has over-all responsibility for research, production, and sales of polyethylene resin, and development work on polypropylene and other polyolefins. He joined Du Pont in 1941 as a chemist at the Experimental Station, near Wilmington, and has held various posts since then. He became PE product mgr. in 1955, and was appointed marketing mgr. of the newly-formed Polyolefins Div. in 1960. **Bailey H. Barnes,** field sales mgr., Polyolefins Div., succeeds Mr. Lecky as marketing mgr.

H. S. Lecky

The Specialty Papers Co., Dayton, Ohio mfr. and converter of flexible packaging materials: **Edward A. Greer** named v-p—marketing; **David K. Evans** promoted to field sales mgr.; **Donald E. Irvin** is tech. dir. in charge of all printing; and **William J. Trimbach** became converting mgr. **Alexander B. Beal** continues as mgr., PE extrusion dept.

U. S. Rubber Co.—Naugatuck Chemical Div.: Clarence H. Sigler Jr. appointed to new post of polyurethane and polyester commodity mgr. **Dr. Thomas H. Newby** appointed to new post of group mgr., plastics R & D. **Edwin A. Hafner** replaces Dr. Newby as mgr., polyester R & D.

Interchemical Corp.—Color & Chemicals Div. R-B-H plant, Bound Brook, N. J.: **Arthur Mastro** appointed mgr., process engineering and control of pigment dispersions for plastics products. He will be assisted by **Phillips C. Decker. Walter Semchyshyn** appointed process engineer, responsible for dispersions for coatings and inks. **Dr. Lino J. Radi** named sales staff rep. and advisor on plastic problems, particularly polyolefins.

Plax Corp., Hartford, Conn., mfr. of plastic containers, oriented PS sheet and film products: **Lawrence E. deNeufville** appointed exec. asst. to the pres. **Samuel F. Peirce** named dist. sales mgr., containers, New York, N. Y. Office.

Acadia Plastics Inc., custom extruder of tubing and shapes, moved from New Hyde Park to new and larger facilities in Westbury, L. I., N. Y.

Archer-Daniels-Midland Co.: Henry E. Billiat Jr., formerly resin sales rep. in Kansas City, Mo., transferred to Minneapolis as tech. specialist in the resin dept. **Leslie J. Perrine,** tech. sales rep. in Los Angeles, replaces Mr. Billiat in Kansas City, and **George Hare** succeeds Mr. Perrine in Los Angeles.

Cary Chemicals Inc., E. Brunswick, N. J. mfr. of vinyl resins and compounds: **Samuel J. Gibson** appointed sales mgr.; **Joseph P. Geris** appointed works mgr.

Philip R. Scarito named works mgr. for the vinyl polymer plant in Flemington, N. J.

Rexall Drug and Chemical Co., Los Angeles, Calif.: **Donald H. Brewer,** v-p in charge of the company's plastic processing operations, and **Ralph M. Knight,** v-p in charge of the chemical div., elected to the company's board of directors.

Paisley Products of Canada Ltd., Scarborough, Ont., appointed sole Canadian agents for **Dynamit Nobel, A.G.,** Troisdorf/Cologne, West Germany producer of semi-finished and end products in the plastics line.

Christopher J. McMahon appointed sales rep. in greater New York City for **The Stanley Chemical Co.,** East Berlin, Conn., a subsidiary of **The Stanley Works.**

George A. F. Schulte named Fla. sales rep. for **Seiberling Rubber Co. Plastics Div.** in Newcomerstown, Ohio. Mr. Schulte will handle the company's line of Seilon plastics, which include various types of vinyls, ABS, polyolefins, and styrene, generally in sheet form.

Edward J. Barbour appointed dist. mgr., upper Midwest region, for **Nixon-Baldwin Chemicals Inc.,** Nixon, N. J. supplier of thermoplas-

tics to the advertising display, optical frame, and packaging industries. He will be in charge of the company's Chicago offices with responsibility for the area between Ind. and Minn.

R. G. Ullrich named Midwest dist. sales mgr. for Vinyl Products by **Ford Motor Co.** Ford vinyl is manufactured in the company's Mt. Clemens, Mich. plant for a variety of uses, including furniture, automotive trim, and outer wear applications.

Alex Mann appointed sales mgr., **Boltaron Div.** for **The General Tire & Rubber Co., Bolta Products Div.,** Lawrence, Mass. In his new capacity he will be responsible for all sales of Boltaron, the tradename for rigid plastic sheet manufactured by the Bolta Products Div.

Dr. Aimison Jonnard appointed v-p, planning, of **Celanese Chemical Co.,** div. of **Celanese Corp. of America.** In his position, he assumes responsibility for both short- and long-term planning of the company. He succeeds **Robert L. Mitchell,** who was named a v-p of **Celanese International Corp.** Since 1959, Dr. Jonnard had been associated with U.S.I., a division of National Distillers and Chemical Corp., which he joined originally as asst. mgr., polymer planning and applications. He was most recently mgr. of market R & D at U.S.I.

Dr. Jonnard

Lawrence E. Davis appointed product mgr., dibasic acids for the **Industrial Chemicals Div., Pittsburgh Chemical Co.** He will be responsible for marketing the firm's phthalic anhydride, maleic anhydride, and fumaric acids.

Marvin L. Shelton named v-p and gen. mgr. of **Loma Industries Inc.,** Ft. Worth, Texas. He continues as pres. of **Southwestern Container Corp.,** an affiliate of Loma, and will serve as operational head of Loma's custom packaging, proprietary, and housewares divisions.

Jerome I. Cohn appointed dir., sales engineering, of **Radiation Materials Inc.,** Long Island City, N. Y. A joint venture of **Loral Electronics Corp.** and **Radiation Applications Inc.,** RMI manufactures both PVC and irradiated polyolefin wire and cable, and is a supplier of the missiles and electronics industry.

W. J. McDade appointed Midwestern field sales rep., pipeline coatings, for **Polyken Sales Div., The Kendall Co.,** Chicago, Ill.

Correction

"Mold design for expandable polystyrene—Part 1" (MPI, Nov. 1961, p. 117): Figs. 9 and 10 were inadvertently transposed.—**End**

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Machinery and Equipment For Sale

FOR SALE—Line of Nylon Cable Clamps designed to meet new military specification. Engineering complete, two molds complete, parts have passed qualification test, includes possible patent rights. Reply Box 7092, Modern Plastics.

FOR SALE—1, P.O. Abbey Mixer 38 x 60; 2, P.O. Abbey Mixers 54 x 36; 3, P.O. Abbey Ball Mills 60 x 60; 1, Calender Roll, W. R. Thropp & Son, 1 set extra rolls and Bearings. Rolls 16" x 30"; 2, Sly Dust Collectors #56 Type 360 dust filter; Conveyors, grinders, Gyro Sifters, Hammer Mills, etc. All in good condition. Reply Box 7093, Modern Plastics.

FOR SALE—Fiber Glass 52" Preformer. Fiber Glass Ovens. Turner Roving Cutter. 500 ton W-S hobbing press. 500 ton Utility five 48" x 30" platens. Four 300 ton Molding Presses various makes. HPM 200 ton downstroke. Watson Stillman 240 ton, ten 24" x 56" platens. W&W 200 ton, 24" x 42." Stokes Standard. 150 and 50 ton semi-automatic. D&B 150 ton, 25" x 25". French Oil 120 ton self-contained. 50 ton Birdsboro 24" x 20". Stokes 15 ton automatics. Hydraulic pumps and accumulators. New ¾" plastic extruder. Other sizes to 6". Banbury #3 Mixer. Seco 6" x 12", 2-roll Mills and Calenders. Farrel & Thropp 40" and 48". Other sizes to 60". Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day jacketed Mixers. Taylor-Stiles Pelletizer 3 HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for Bulletin #194. We buy your surplus machinery. Stein Equipment Company, 107-8th Street, Brooklyn 15, New York. ST 8-1944.

FOR SALE—Foremost 10" x 12" Rotary Cutter 5HP. B&J Rotary Cutters size #½ & #1 10HP. 16" x 30" Thropp Rubber Mill 75HP. Ribbon Blenders 600, 1000, 3000 lbs. 150 Gal. Day Imperial Mixer, jacketed sigma blades. Peerless Rubber Bale Cutter M/D. Pony Mixers 2½, 8, 15, 40, 80 Gal. Keith Machinery Corp. 73-15th St., Bklyn, N.Y. ST 8-5502.

FOR SALE—(2) 6" Hartig late model, electrically heated extruders. Excellent condition, now in use on styrene sheet. Each has 100 HP, 440 V., new Louis Allis motor, still in crate. No head or temp. control included. Head can be designed for your special purpose. A bargain at $11,000.00 each. Also Royle rebuilt 2", 3½", 4½", 6", 8½" extruders to meet any requirement. Hot plastic strainers our specialty. Our equipment guaranteed. Videx Equipment Corp., 444 Hartung Drive, Wyckoff, New Jersey. Tel: TW 1-3040.

MOST MODERN PACKAGING AND PROCESSING MACHINERY AVAILABLE AT BARGAIN PRICES—Baker Perkens, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75 and 100 gal. capacities. Day, Robinson 50 to 5,000 lb. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and Enamel. Devine (Porter) 650 gal. Steam Jacketed Double Spiral Mixers. Day Imperial 50, 75 and 100 gal. Double Arm Mixers. Sigma, Dispersion Blades. Mikro No. 6 Stainless Steel Atomizer with Collector. Mikro Pulverizers, Models Bantam, 1SH, 2DH (S.S.) 2TH, 3TH and 4TH. Fitzpatrick Models D and K-8 Stainless Steel Comminuters. Colton Model 241 Double Rotary High Speed Tablet Press. Package Machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning Machines — Ceco Models 40 and A3901, Pneumatic Scale, Jones. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N.Y., Phone CAnal 6-5333.

FOR SALE—1—Baldwin Southwark 150 ton self-contained compression molding press; 1—Watson Stillman 1 ounce vertical injection molding machine; 1—Hartig 4½" electrically heated plastics extruder; 1—Stokes model 800—15 ton automatic molding press; 1—Ball & Jewell #1 rotary cutter, 10 HP. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N.Y. HY 9-7200.

FOR SALE—Midget Banbury mixer Cumberland 14" pelletizer. Aaron Equipment Company. 9370 Byron St., Schiller Pk., Ill. Tel: 678-1500.

FOR SALE—Tablet Presses: Kux #82, Mechanical and hydraulic, 150 ton. Stokes Model R, with 3 HP drive. Stokes Molding Presses. 50 Ton, model 741. Full automatic. Blow Molding Set Up—2" Kato. One year old, complete with all controls and blow molding equipment. With variable speed drive. Injection Molding Machines—1 oz. Van Dorn, 4 oz. Harvey, 8 oz. Reed Prentice, 12 oz. DeMattia, 12 oz. Reed Prentice, 16 oz. HPM. All in stock. Immediate Delivery. 1" NRM Lab Extruder, complete with drive and controls. 2" National Erie, Electrically heated extruder with vari drive and extra screws. Scrap Grinders—Ball & Jewell #1½ with 25 HP Motor Drive. Cumberland 2 stage, with 20 HP motor drive. Like New. We have a full line of Laminating Presses, Molding Presses, Mills, Calenders, Extruders, Injection Molders, Scrap Grinders, Coating Equipment and other accessories for the Plastic Industry. We Will Finance. Johnson Machinery Company, 90 Elizabeth Ave., Elizabeth, N.J. EL 5-2300.

FOR SALE—Hilker polyethylene bag maker—handles bags up to 14" wide by 27" long. Equipped with additional unwind stand for running several webs simultaneously. Average yield—5,000 bags per hour. Priced for quick sale at $400.00. H & R Plastics Industries, Inc., Nazareth, Pa.

FOR SALE—Liquidating chemical plant, Little Rock, Arkansas: Worthite 2" x 1½" & 3" x 2" cent. pumps; Baker-Perkins #16-UUEM, 150 gal. jacketed dispersion mixer, 150 HP XP drive, Vaulted cover; 100 gal. Baker-Perkins T347SS jacketed dispersion blade mixer; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 stainless jacketed resin kettle; American 42" x 120" dbl. drum dryer, ASME code, stainless trim; 2600 gal. T316 stainless pressure tanks, coils, dished heads; 800 sq. ft. T316 SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Worthington 70 cu. ft. rotary blender; Sturtevant 75 cu. ft. Stainless rotary blender; we pay cash—top dollar—for idle, surplus equipment. Perry, 1429 N. 6th St., Phila. 22 Pa.

FOR SALE—Reed Prentice Molding Machines 10D12—Serial #62067—Advance Ram—weigh feeder—3 Wheelco Instruments. $9,500.00. 450T20—Serial #61926 Weigh Feeder—3 Wheelco Instruments. $19,500.00. 600H24—Serial Nos. 37959 & 58516 weigh Feeder & 3 Wheelco Instruments. Both 600H24's rebuilt & provided with reinforcing "C" Yokes to strengthen bed keys. All machines are in operation. $14,500.00 Ea. Amerline Corp., 2727 W. Chicago Avenue, Chicago, Illinois.

INJECTION MOLDING—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Baker-Perkins SS 100 Gal 2 Arm Jac. vac. Hyd. tilt 50 HP; 150 Gal Day Imperial Sigma; 3 Baker-Perkins 100 Gal Sigma Jac. Hyd. tilt; 2—3" x 8" Thropp Mills; S.S. Tank 5,700 gal.; Extruder 8" elec. heated; Ram extruder. Machinecraft Corp., 800 Wilson Ave., Newark, N.J. MI-2-7634.

FOR SALE—1 eight drawer Despatch oven, all controls automatic. Excellent for nylon, butyrate, acetate, etc. First $200.00 offer takes. Will crate for $40.00 f.o.b. Midwest Plastics Corporation, 451 North Water, Wichita, Kansas, AMherst 2-1745.

FOR SALE—Must sell immediately to best offer Guy P. Harvey 3 oz. fully automatic, fully equipped, complete with two moulds for cigar tips, 20 cavities each, package originally cost over $20,000, run less than 200 hours, new, can be seen by appointment. Reply Box 7094, Modern Plastics.

PACKAGING EQUIPMENT IMMEDIATELY AVAILABLE FROM STOCK—1—R. A. Jones Model CMV Cartoner; 2—Packomatic Semi-Auto. Carton Gluers; 1—ABC Model XSA Auto. Carton Gluer; 4—Std. Knapp Model 429 Carton Sealers; 1—Ceco Model A-3901-1Z Carton Sealer; 2—Pneumatic Scale in line Bottle Cleaner; 1—Karl Kiefer Rotary Bottle Cleaner; 1—Chisholm Ryder Model NWS Jar Cleaner; 2—Hope 4 Piston Fillers; 5—Geyer Piston Fillers, 1 to 11 Piston; 5—M & S 10 Pocket Fillers; 1—K K Visco 2 stream filler; 1—M & S 6 pocket filler for #10 cans; 2—Pneumatic Scale 16 spout SS Rotary Gravity Fillers; 1—Horix Model HEV-1433 Vac. Filler; 1—Karl Kiefer 18 spout Vac. Filler; 1—Berlin Chapman 7 head Syruper or Briner; 1—Berlin Chapman 15 head Syruper or Briner; 2—Diehl Mateer Model 31A Fillers; 4—Stokes & Smith Universal single auger Filler; 1—Stokes & Smith Model HG87 Twin Auger Filler; 1—Stokes & Smith Model HG88 Packer & Weigher; 1—Weigh-Right Pak King Volumetric Filler; up to 10 oz; 1—Weigh-Right Model C-1 Volumetric Auto. Filler up to 2 oz; 1—Cherry Burrell 6 wide bottle washer; 1—16 Spout Rotary Bottle Rinser; 2—Resina single head Screw Cappers; 3—Capem 4 head Screw Cappers; 1—U.S. Model RC3 Auto. Screw Capper; 1—Pneumatic Scale 4 head Screw Capper; 1—Capem Model K-4 Kottoner; 2—Std. Knapp Wrap-A-Round Labelers, up to gallons; 1—Standard Knapp Model A Vertical Labeler; 2—Pneumatic Scale 5" Duplex front and back labelers; 1—N.J. Pony Labeler #86-TORF; 1—N.J. Pony Labeler #86M; 1—Std. Knapp Model 806 Packer; 3—Std. Knapp Model F Packers; 1—Burt Model PCE Packer; 1—Canco #006 Seamer for 211 cans; 2—Angelus 29P for 211 and 303; 1—Panama Seamer for Quart Cans; 2—Western Seamers for 2½ & #10 cans; Blown Film Extruders—Embossing Calendars. First Machinery Corp., 209-289 Tenth St., Bklyn. 15, N.Y. Sterling 3-4672. Cable: "Effemcy."

FOR SALE — Reed Prentice Plastic Presses: 1951 4 oz. Model 5A4 Serial 60019, very clean, in perfect condition, with all controls, $3800.00. 1954 Model 175T 4-6 oz Serial 62446, spare IMS cylinder, 4 zone control for nylon, excellent condition, $10,000.00. Punch Press: 1952 37T #4 L&J #41699, complete with motor and controls, good condition, $750.00; with roll feed, $950.00. All machines FOB, Sterling, Illinois. Wahl Clipper Corporation, Sterling, Ill.

FOR SALE—Injection presses: 32 oz. H.P.M.—1952, $15,000., 48 oz. H.P.M.—1953, $20,000., 48 oz. H.P.M.—1954, $25,000. All equipped with pre-plasticizers. In good condition. Can be inspected in operation. Mutual Plastic Mold Corporation, 5141 Firestone Place, South Gate, California. LO 4-2481.

FOR SALE—(1)—Thropp 2-Roll Mill 18" x 50", 6" x 12", 2" x 6", complete with motors; (2)—Cumberland #18 and #½ Gradulators with motors; (3)—Baker-Perkins 50, 100 and 150 gal. Sigma blade jacketed Mixers; (1)—P-K 1 cu. ft. 304 SS "V" Blenders; (3)—Mikro Pulverizers, Bantam, 1SH and 1Si; (5)—Stokes Preform Presses, models R, T, DD2, DDS2 and D4; partial listing, send for details. Brill Equipment Company, 35-55 Jabez St., Newark 5, N.J. Tel: MArket 3-7420.

(Continued on page 228)

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(Continued from page 226)

Machinery Wanted

WANTED—One Lake Erie 15 ton Flow Test Press. Must be in good condition. Reply Box 7096, Modern Plastics.

WANTED—32 to 48 ounce Plastic Machine in running order. Write full details, Box 7097, Modern Plastics.

WANTED—Used light transfer molding press, comparable to 30-ton Watson-Stillman #9792-C. Also, used 1 kilowatt plastics preheating unit. Forward details and prices in first letter to: Plastics Dept., Ace Electronics Associates, Inc., 99 Dover Street, Somerville, Mass.

WANTED TO BUY—Four ounce Lester Injection Molder, solid frame, late model, in good condition. Reply Box 7098, Modern Plastics.

Materials For Sale

FOR SALE—Reprocessed high and medium impacts 20,000 lbs. each natural, red, white, blue and yellow. Also color matching acetate—clear, red, blue, white, yellow, black. Color matching, Polyethylene—Natural, all colors and fluorescents. Special color matching. Plastic Molding Powders, Inc., 487 Forest St., Kearny, N. J., N. Y. Phone WH 4-5725-6, N. J. Phone WY 8-0044-6.

FOR IMMEDIATE SALE: Large quantities of Ethyl Cellulose at important savings. Claude P. Bamberger, Inc., Ridgefield Park, N. J. Hubbard 9-5330.

RAW MATERIALS for the Plastics industry—virgin Polystyrene, Polyethylene and Vinyl compounds. Crystal, Natural and colors. Large and continuing quantities available. Export inquiries invited. Alan Plastics Corporation, Canton, Mass.

Materials Wanted

EUROPEAN FIRM WANTS — Thermoplastic Scrap, surplus lots and reclaims from Acetate, Butyrate, Nylon, Polypropylene, PVC. Reply Box 7099, Modern Plastics.

MATERIALS WANTED: Wanted several truckloads of Cycolac "T" or Kralastic "MH", separated light mixed colors or natural off-grade. Also, need Cycolac "C" or Kralastic 2938 natural. Send small sample of each color stating type, quantity, flow and price. Reply Box 7100, Modern Plastics.

WANTED — PLASTICS OF ALL KINDS — virgin, reground, lumps, sheet and reject parts. Highest prices paid for styrene, polyethylene, acetate, nylon, vinyl, etc. We can also supply virgin and reground materials at tremendous savings. Address your inquiries to: Goldmark Plastic Compounds, Inc. 4-05 26 Ave. Long Island City 2, N. Y. RA 1-0880.

PLASTIC SCRAP WANTED: Sell us your year-end surplus inventories of plastic scrap or surplus molding powders of: Acetate, Acrylic, Styrene, Butyrate, Cycolac, Kralastic, and Tyril, etc. in any form. Write, wire or phone collect: Philip Shuman & Sons, Inc., 571 Howard St., Buffalo 6, N. Y. Tel: TL 3-3111.

WANTED: V-100 or HM-140 Acrylic—clean regrind. Will take metallized or painted Acrylic parts before grinding. Send sample and state pounds or number of pieces of each available. Also, have requirement for painted or metallized Cyc. "T" or Kralastic "MH" in volume lots. Parts must be unground. Send sample and quantities of each available to Box 7101, Modern Plastics.

PLASTIC MANUFACTURERS—I need a plastic that can be used as a cover for golf balls. It should be white, tough and resilient enough not to crack under repeated impact. I will appreciate information and suggestions on this subject from any informed person. Reply Box 7102, Modern Plastics.

Molds For Sale

MOLDS: 10" Dump Truck. 8" Oil Truck. 4 ass. 6" Trucks. 8" Chevrolet 1960. 7" Caterpillar Tractor. 8" Airplane. 6" Fighter Plane. 11" Helicopter. 13" Platform Trailer. 6" Farm Tractor. 17-cav. Railway Accessories. 10"&12" Waste Basket. 1&2 Quart Pitcher. Icecube Tray. 2 sizes Refr. Cont. 3 sizes Freezer Boxes. 10-gal. Refuse Can. Step-on Can. Breadbox. Oval Laundry Basket. 16-cav. Pocket Comb. 12-cav. Purse Comb. 8-cav. Men's Comb. Molds in exc. cond. & low-priced. Alfred A. Rosenthal, 3 Park Row, New York, N.Y.

FOR SALE—1 Push Button Pen Mold. 1 Sunglass mold. Both in perfect condition, hardly used. Box 7103, Modern Plastics.

Help Wanted

EUROPEAN CHEMICAL CO. has need for a consultant: Polyamide Molding Compounds. We demand process improvement, new processes, application know-how, etc. Contact: Havas n° 260/598 rue Vivienne 17,—PARIS (France).

INJECTION MOLD DESIGNER—Southern New Jersey Plastics Molder requires exp. Injection Mold Designer. Hot runner Automatic unscrewing and Cam Action exp. essential. Give complete resume and sal. desired. Apply Box 7104, Modern Plastics.

MANUFACTURERS REPRESENTATIVE WANTED To Solicit OEM accounts on straight commission basis. We specialize in custom injection molding of thermoplastics only. Desire representation in Atlanta, Dallas, Pittsburgh, New York, Chicago and other areas. Write to Sales Mgr., Gulfstream Plastics, Inc., Subsidiary of O'Sullivan Rubber Corp., 3597 E. 10th Ct., Hialeah, Fla.

FOREMAN — INJECTION MOLDING — Precision molder needs Press Room Foreman. Must be top notch and have extensive experience in quality work. Established plant located in South Florida. Send resume, photo and salary desired to Box 7105, Modern Plastics.

LAMINATING AND PRINTING EXPERT NEEDED. Excellent opportunity. Contact Mr. Rudd, Rudd Plastics, Bklyn, N. Y. HY 2-3800.

WANTED—Project engineer with experience in urethane foam and rotationally molded plastisols for well established plastic molder in Detroit area. Good future for man capable of customer contact on an engineering level with the automotive "Big 3." Reply Box 7106, Modern Plastics.

COMMERCIAL DEVELOPMENT—We are an expanding company in the fields of chemicals, polymers and plastic products. Openings exist that require imaginative, ambitious men to do a combination of market research, economic evaluations and market development for a wide variety of new products. If you have a degree in chemistry or chemical engineering with applicable experience in the chemical or plastics industry and want to broaden your horizons, send your resume to: Director of Commercial Development, The Richardson Company, 2789 W. Lake Street, Melrose Park, Illinois.

WANTED—Project engineer or supervisor with profile extrusion experience to take charge of extrusion department as well as customer contact in established Detroit area plastic plant. Good solid future for a man with proven experience. Reply Box 7107, Modern Plastics.

SHEET EXTRUSION FOREMAN — All-around plastics production man to run new German extrusion sheet line on a 24-hour basis. Excellent growth potential. Stamford, Conn. Reply Box 7119, Modern Plastics.

SALESMAN with heavy plastic resale experience. Managerial caliber for plastics distributor opening new branch Eastern area. This is an important and progressive post offering excellent prospects to a man of ability and initiative and salary will be paid fully commensurate with qualifications and experience. Send resume and references to Box 7108, Modern Plastics. Information accorded strictest confidence.

SALES REPRESENTATIVES wanted for the following territories: Wisconsin, Minnesota, Missouri, Kentucky, Michigan, Kansas and Indiana and surrounding area to sell complete line of resins to the paint industry and/or a complete line of polyester resins for reinforced plastics. American Alkyd Industries of Illinois, with the newest and largest Synthetic Resin Plant located in Carpentersville, Illinois, is interested in Representatives and Salesmen with definite large volume accounts available. Write full details to: C. J. Hauck, President, American Alkyd Industries, Carlstadt, New Jersey.

PLASTIC COMPOUND SALESMAN—Growth co seeks person expd with buying & selling virgin & reprocessed vinyl. State experience & salary. Box 7109, Modern Plastics.

M.E. OR CH.E.—Experienced engineer to head new vacuum forming operation in established growth company. Should be familiar with equipment and die design, materials, operation and cost estimating. Will work closely with sales. Send complete resume to: Manager of Industrial Relations, National Vulcanized Fibre Company, Wilmington 99, Delaware.

PLASTIC EXTRUDER ENGINEERS—Seeking advancement? In a rut? Want to make better use of your talents and potentialities? NRM has unlimited opportunities for two men who can demonstrate their ability to "get the job done." Please send resume of education, experience, and salary requirements to J. F. Stroup, Chief Engineer, National Rubber Machinery Company, 47 W. Exchange St., Akron 8, Ohio. All replies held confidential.

PRODUCTION MANAGER — CALENDERED VINYL FILM. Eastern plant calendering lightweight vinyl film needs an experienced production man to supervise every operation of the plant. Must have years of experience in producing vinyl film and its formulations. Please give full details of background and experience. Your confidence will be respected. Reply Box 7110, Modern Plastics.

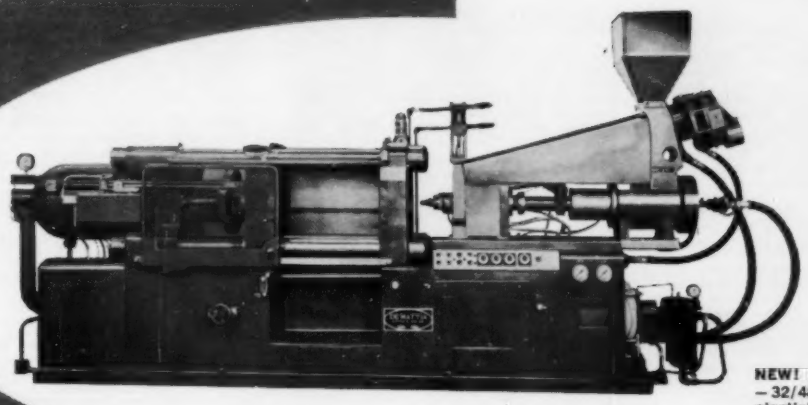
HOOKER CHEMICAL CORPORATION—leading producer of resins and molding compounds—has opening for recent graduates with Bachelor's degrees for positions in Plastics. Chemists, for research, development and application research. Mechanical Engineers, for design and maintenance engineering. Excellent training program, with future opportunities for transfers for qualified applicants to technical service, sales or other areas of interest. Send complete resume to: Mr. James J. Feeney, Manager of Industrial Relations, Durez Plastics Division, Hooker Chemical Corp., North Tonawanda, N. Y.

REPRESENTATIVE for the sale of injection molding machines and auxiliary equipment wanted in the West, South and Canada. Write to: Acme Machinery, 62 Hammond Street, Worcester, Mass.

ASSISTANT PLANT MANAGER—Polyvinyl experience required. Challenging growth opportunity with expanding multiplant corporation. East Coast location. Send full resume in confidence to Box 7111, Modern Plastics.

PLASTIC EXTRUSION ENGINEER — Man to take complete charge of extrusion department. Must know die design, production of rods, tubes and profiles. Excellent opportunity for right man. Our employees know of this ad. All replies in strict confidence. New York Metropolitan area. Reply to Box 7112, Modern Plastics.

(Continued on page 230)



NEW! PREPLASTICIZER MODEL – 32/48-oz; 300 lbs./hr. plasticizing capacity; variable speed hydraulic screw drive.

INJECT PERFECTION IN YOUR MOLDING

Give yourself every opportunity for better, faster, more profitable production with De Mattia injection molding machines.

From the brand-new *preplasticizer* model to the equally new and immediately accepted Model J 2-ounce, there is a De Mattia fully automatic, fully hydraulic machine to meet your specifications.

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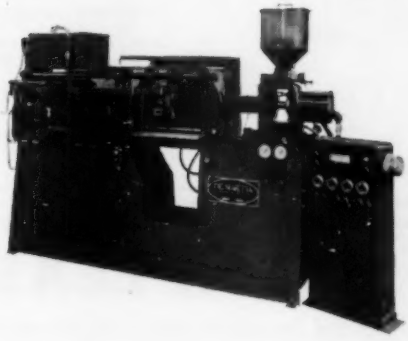
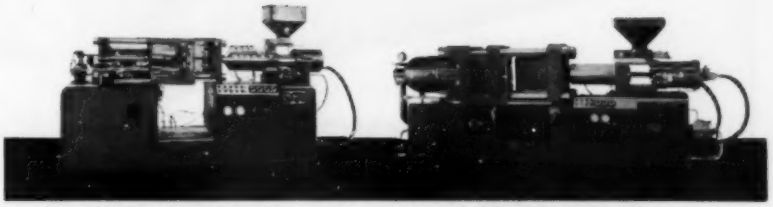


NEW! 2-OZ. MODEL J – fastest fully hydraulic, fully automatic, molding machine ever built; only one of its kind in the world.



4/6-OZ. MODEL K-2 – the maximum in continuous, dependable, easy operation for record-breaking production at minimum cost.

12/16-OZ. MODEL M-2 – the standard for the industry, practically guarantees production increase up to 20%; 42" max. daylight; 400-ton clamp.

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Sales Representatives: ACME MACHINERY & MANUFACTURING CO., INC., 500 Saw Mill River Rd., YONKERS, N. Y.; 102 Grove Street, WORCESTER, MASS.

(Continued from page 228)

PLANT SUPT. For Large Injection Molder. Propietary & Custom AAA-1 firm offers excellent Oppty. to right man. Must have—Supervisory background. Knowledge all plastic material. Engineering Maintenance & Production. Office & Plant responsibility. Report directly to Div. of Vice President. Willing to relocate. Liberal benefit program. Send resume & salary desired to: Mr. O. W. Van Cleaf, Diamond Plastics Industries, Box 326, Roanoke, Virginia.

PLASTISOL CHEMIST—Opportunity for growth in aggressive organization, for chemist experienced formulating and testing plastisols and organosols. Must have knowledge and ability to develop compounds to certain specifications with minimum of supervision. Write advising present position, salary level, and experience. Dennis Chemical Company, 2701 Papin Street, St. Louis 3, Missouri.

PLASTICS RESEARCH CHEMIST—M.S. or PhD. preferred, or B.S. with depth of experience in plastics compounding research, to fill a top position in our CAB-XL program. Position requires tailoring of cross-linkable polyolefin compounds and evaluation of properties. Salary will be dependent on qualifications. Liberal benefit program. For prompt and careful consideration write to: John M. Clark, Cabot Corporation, 125 High Street, Boston 10, Massachusetts.

ENGINEER, PLASTIC INJECTION MOLDING. Experience preferred, to follow through on mold design and building, for growing New York City company in the packaging field. Excellent opportunity. Send detailed resume education, experience, and salary expected. Reply 7113, Modern Plastics.

Situations Wanted

REINFORCED PLASTICS—CHIEF ENGINEER—Presently directing research and development in reinforced plastics for high stress, high temperature applications seeks challenge. Experienced in Mold Design, Compression, molding complex parts, Physical testing, Adhesive bonding, Coatings. Canadian, under 35, eligible security clearance. Reply Box 7114, Modern Plastics.

FOREMAN—Adjuster Weber paper bag machine, specialty. 12 years experience. References upon request. Reply Box 7115, Modern Plastics.

INJ. MOLDING SUPERVISOR—Experienced Technician-Specialist in Injection Molding seeks responsible position with reliable molding company. Ability to set up new operation or improve existing techniques. Married. Under 30. Relocation no problem. Write giving company particulars, indicating position and outlining scope of responsibilities. Challenge welcomed. Reply Box 7116, Modern Plastics.

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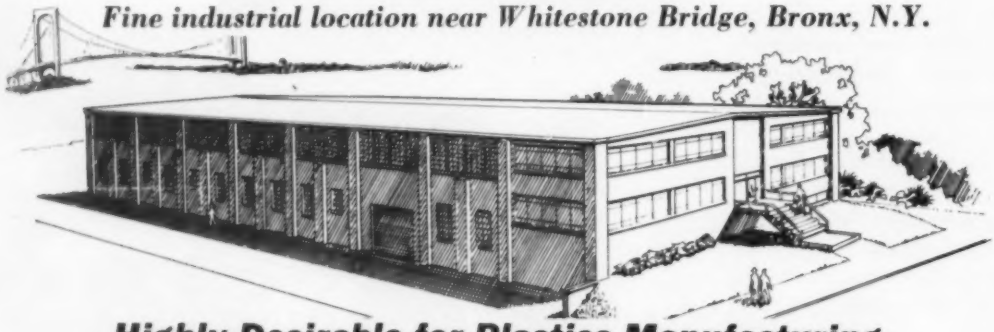

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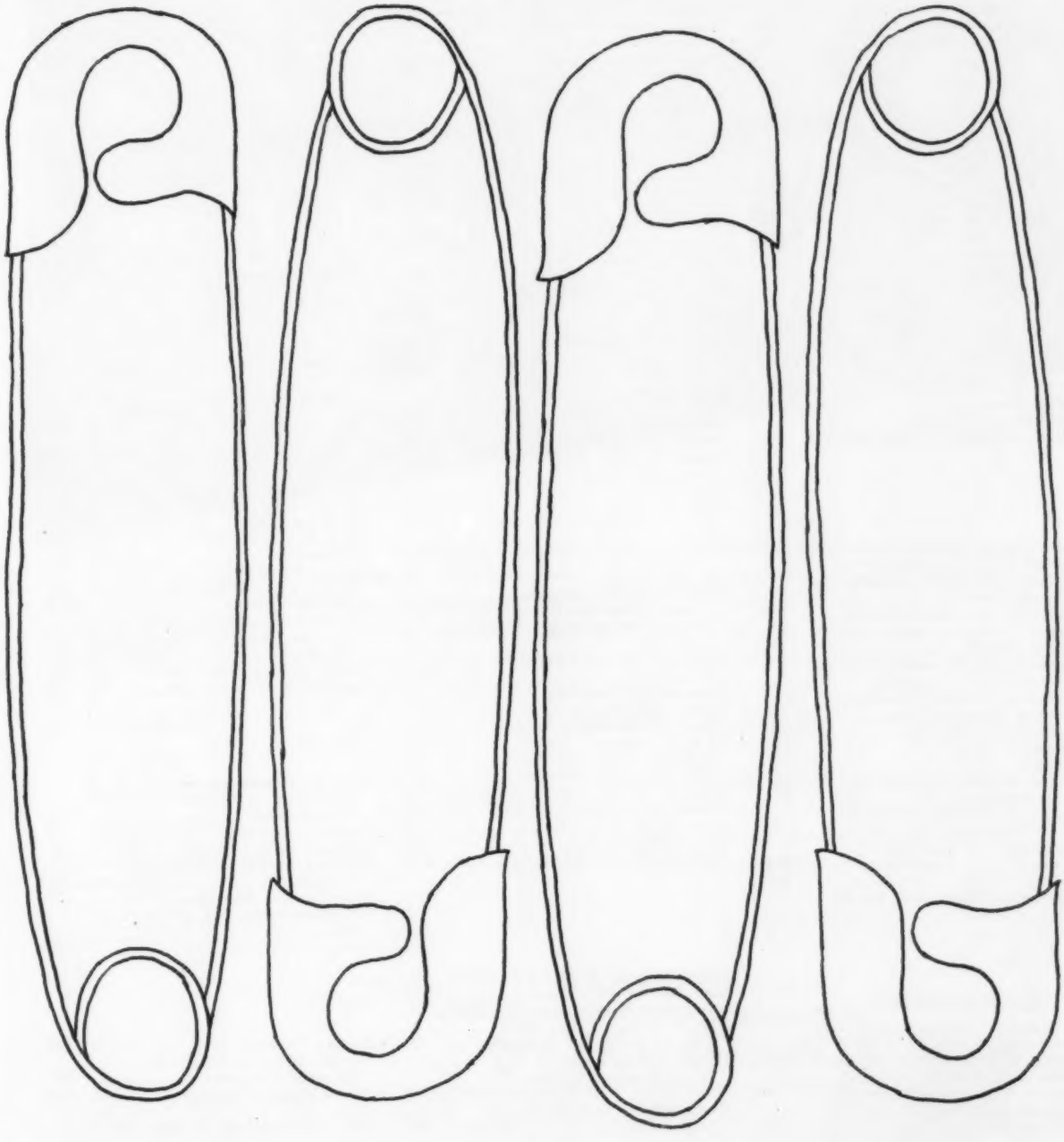

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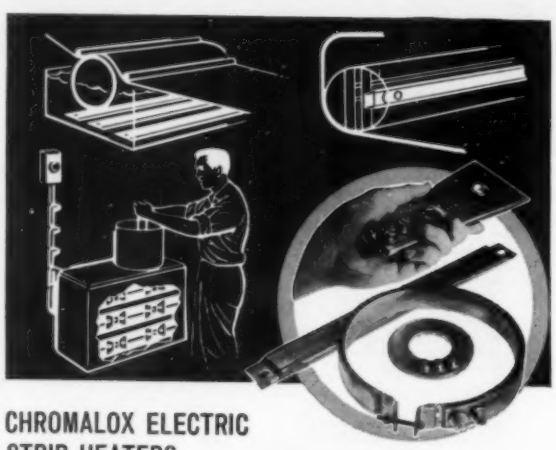

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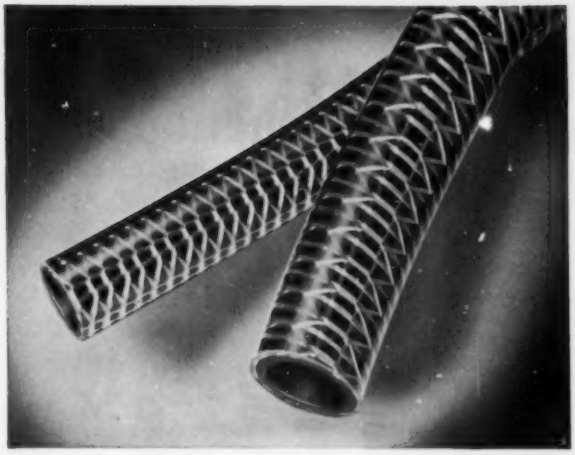

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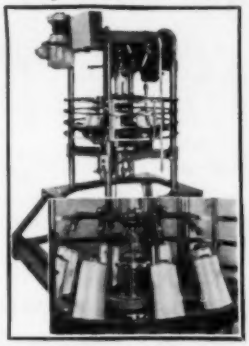

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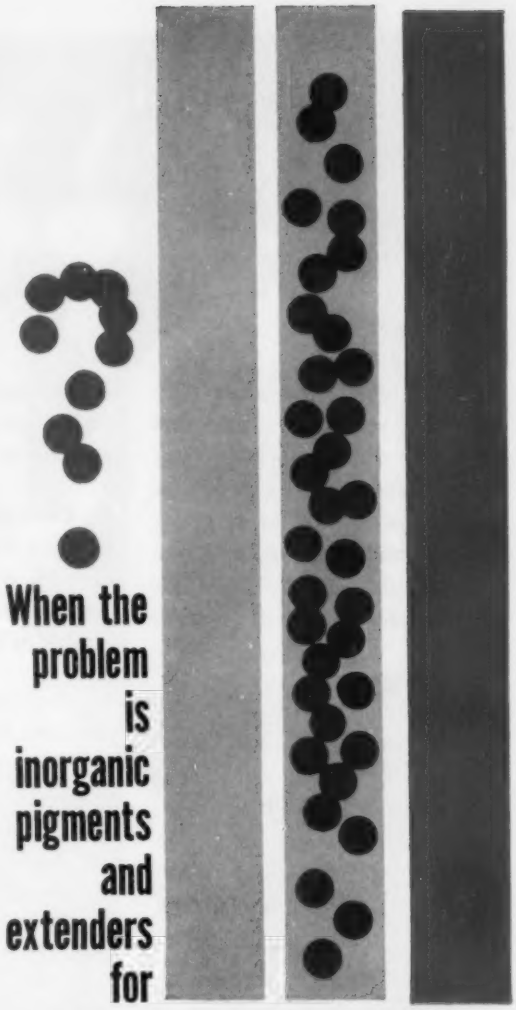

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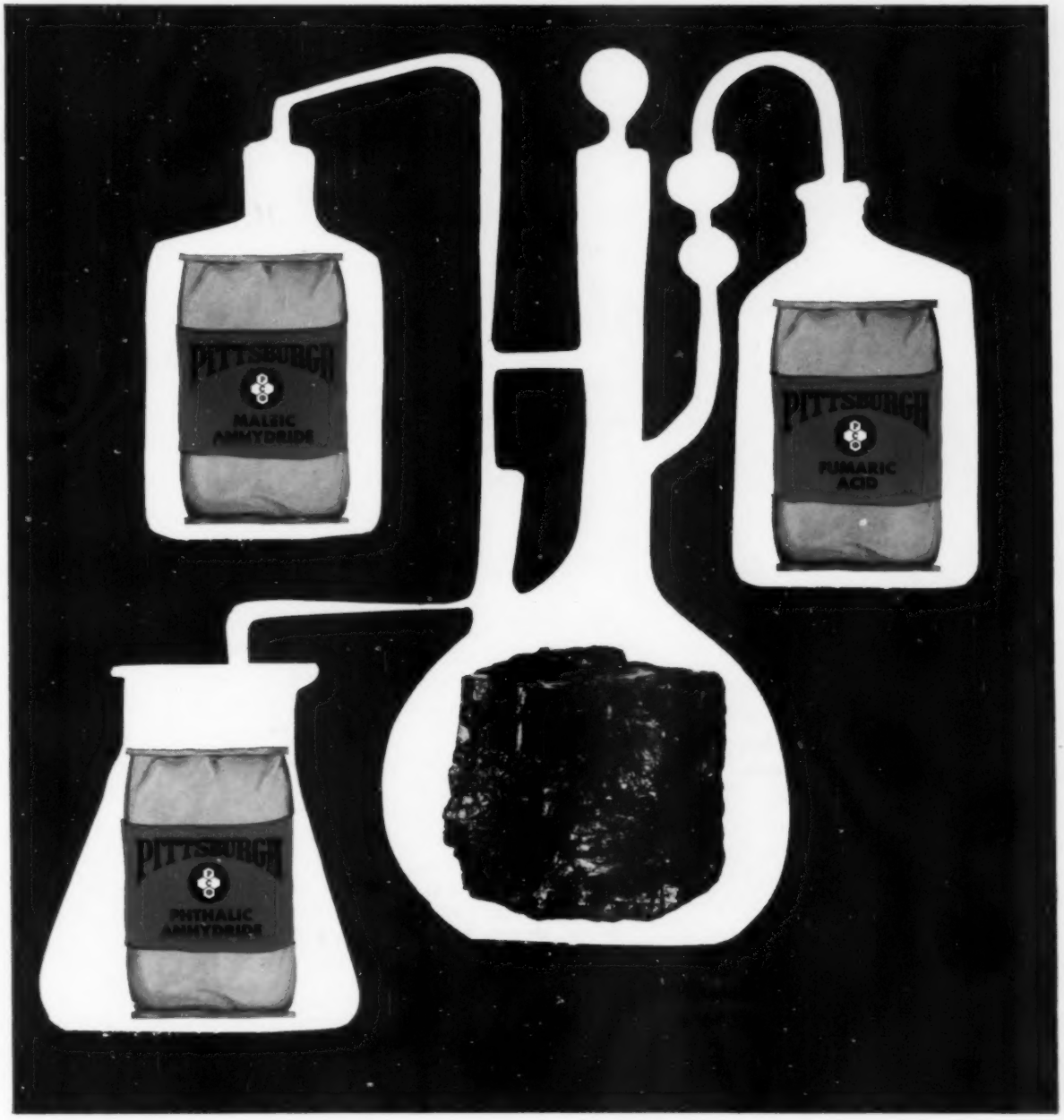

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